AVRO AIRCRAFT

TECHNICAL REPORT

A. V. ROE CANADA LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT (Aircraft)

ANALYZED

ANALYZED

AIRCRAFT:

REPORT No: 7/0558/67

FILE No:

No OF SHEETS: 96

TITLE: ONE-WAY COOLING AIR VENTS

~~CONFIDENTIAL~~

Classification cancelled / Changed to UNCLASS
By authority of AVRS
Date 30 Sept 96
Signature RPSully
Unit / Rank / Appointment AVRS 5

PREPARED BY M. SEVIK, E. KANTT, R. MELVILLE DATE JAN. 56

CHECKED BY DATE

SUPERVISED BY DATE

APPROVED BY DATE

ISSUE No.	REVISION No.	REVISED BY	APPROVED BY	DATE	REMARKS
					15865835

FORM 1316A

AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT: C 105	AIR VENTS	REPORT No. 7/0553/67 SHEET No. A

PREPARED BY	DATE
KAUTT	5/25/56
CHECKED BY	DATE

CONFIDENTIAL

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FORM 1319A

AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

REPORT No. 7/0558/07
SHEET No. A

AIRCRAFT:		PREPARED BY	DATE
C 105	AIR VENTS	KAUTT	5/25/56
		CHECKED BY	DATE

CONFIDENTIAL

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FORM 1319 A

AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

REPORT NO. 7/0558/67
SHEET NO. 0-1

AIRCRAFT:		PREPARED BY	DATE
C 105	AIR VENTS	KAUTT	5/25/56
		CHECKED BY	DATE

INTRODUCTION

THE PURPOSE OF THIS REPORT IS TO ANALYZE THE REINFORCING STRUCTURE AROUND THE AIR VENTS IN THE SIDE & BOTTOM OF THE FUSELAGE, THE DUCTS & THE DUCT DOORS.

THE REINFORCEMENTS AROUND VENTS 1&2, 3&4, & THE VENT BETWEEN STN 702.30 & STN 707.32 REQUIRE SPECIAL ATTENTION BECAUSE OF THE NATURE OF THE STRUCTURE. THIS STRUCTURE IS IN THE FORM OF A TRUSS & IS MADE OF ALLOY STEEL. THE ASSUMPTIONS MADE IN THE ANALYSIS OF THIS STRUCTURE ARE AS FOLLOWS:

1) TRUSS STRUCTURE IS PIN-JOINTED.
2) SHEAR FLOW ON ALL SIDES OF TRUSS IS A UNIFORM 1600 #/"

THE TRUSSES WERE STRESSED ON THESE ASSUMPTIONS, i.e. AXIAL LOAD ONLY IN THE TRUSS.

ASSUMPTION (2), ABOVE, MEANS THAT THE TRUSS IS EXPECTED TO CARRY THE SAME AMOUNT OF LOAD AS WOULD BE CARRIED BY THE SKIN IF THERE WERE NO CUTOUT, i.e. 1600 #/". THIS IN TURN, MEANS THAT THE SKIN ABOVE & BELOW THE CUTOUTS WILL HAVE THE SAME STIFFNESS AS THE TRUSS REINFORCEMENT. SINCE THE TRUSS IS FAR FROM BEING PIN-JOINTED, & SINCE THE CONDITIONS WHICH ASSUMPTION (2) IMPOSES ARE NOT LIKELY TO BE MET, AN ATTEMPT WAS MADE TO JUSTIFY THEM. THIS WAS DONE IN SECTION 2. THE CONCLUSIONS & RECOMMENDATIONS RESULTING FROM THIS STUDY ARE PRESENTED ON SHT. 0.2.

FORM 1319A

AVRO AIRCRAFT LIMITED MALTON - ONTARIO TECHNICAL DEPARTMENT		REPORT NO. 7/0558/67. SHEET NO. 0.2.	
		PREPARED BY	DATE
AIRCRAFT: C. 105.	AIR VENTS.	D. BRIDGNELL.	5/10/56.
		CHECKED BY	DATE

INTRODUCTION CONT'D.

DRAWINGS COVERED.

7-1058-5075/6 - VENTS 1 AND 2.
7-1058-5105/6 - VENTS 3 AND 4.
7-1058-5755/6 - VENTS 5 AND 6.
7-1058-6413 - COILED SPRING.
7-1058-6415 - FLAT SPRING.
7-1058-4707/8 - VENT BETWEEN STN: 702.3 AND 707.32.
7-1058-6217 - PRESSURE VENTS 7 AND 8.

DRAWINGS REFERRED TO

7-1058-57/8 - FORMER - STA 668.45 SIDE STRUCTURE.
7-1058-5105/6 - PRESSURE VENTS 3 AND 4. (MENTIONED ABOVE).
7-1058-5075/6 - [illegible] " [illegible] 1 AND 2. (" ").

FORM 1319 A

AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT:		REPORT No: 7/0558/67	
C 105	AIR VENTS	SHEET No. 0.3	
		PREPARED BY	DATE
		KAUTT	5/29/56
		CHECKED BY	DATE

CONCLUSIONS & RECOMMENDATIONS

THESE ARE CONCERNED WITH THE STUDY MADE IN SECTION 2 ONLY.

THE MAXIMUM VERTICAL DEFLECTION OF ANY TRUSS JOINT WITH RESPECT TO ANY OTHER JOINT IS JOINT Ⓒ WITH RESPECT TO JOINT Ⓓ (REF. DIAGRAM, SHT. 2.1). A WILLIOT DIAGRAM WAS CONSTRUCTED, ASSUMING THE TRUSS TO BE PIN-JOINTED. THE RELATIVE VERTICAL DEFLECTION OF JOINT Ⓒ WITH RESPECT TO JOINT Ⓓ WAS FOUND TO BE .1471" (SAME AS FOR ANALYTICAL SOLUTION, SEE SHT. 2.3) THEN THE FACT THAT THE TRUSS IS NOT PIN-JOINTED WAS TAKEN INTO ACCOUNT, & THE MOMENTS AT THE JOINTS DUE TO THE DEFLECTIONS AS DETERMINED FROM THE WILLIOT DIAGRAM WERE CALCULATED BY MEANS OF THE MOMENT DISTRIBUTION (HARDY CROSS) METHOD. THE JOINT MOMENTS WERE FOUND TO BE OF SUCH A MAGNITUDE AS TO CHANGE THE TRUSS AXIAL LOADS APPRECIABLY. THEREFORE, THE EFFECT OF THE AXIAL LOADS WAS DETERMINED (SHTS. 2.13 – 2.15), & A NEW WILLIOT DIAGRAM WAS CONSTRUCTED (SHT. 2.17). THE VERTICAL DEFLECTION OF JOINT Ⓒ WITH RESPECT TO JOINT Ⓓ WAS FOUND TO BE .1170" FOR THE NEW AXIAL LOADS. NEW JOINT MOMENTS WERE CALCULATED. AT THIS POINT, LACK OF TIME PREVENTED ANY FURTHER REFINEMENT OF THE ANALYSIS. HOWEVER, THE FOLLOWING CONCLUSIONS MAY BE DRAWN:

A) IF THE EFFECT OF THE NEW MOMENTS (SHT. 2.20) ON AXIAL LOADS IS CALCULATED, THE NEW AXIAL LOADS WILL BE SLIGHTLY HIGHER THAN THOSE SHOWN ON SHT. 2.15, BUT CONSIDERABLY LOWER THAN THOSE CALCULATED ASSUMING PIN JOINTS (SHT. 2.7).

B) IF A NEW WILLIOT DIAGRAM WERE CONSTRUCTED USING AXIAL LOADS OF (A) ABOVE, THE VERTICAL DEFLECTION OF JOINT Ⓒ WITH RESPECT TO JOINT Ⓓ WILL BE FOUND TO BE SLIGHTLY GREATER THAN THAT FOUND FROM THE WILLIOT DIAGRAM (SHT. 2.17) BUT CONSIDERABLY LESS THAN THAT FOUND FROM THE FIRST DIAGRAM (SHT. 2.8).

C) IF THE PROCEDURE OUTLINED IN (A) & (B) IS CARRIED OUT, & NEW JOINT MOMENTS CALCULATED (WHICH SHOULD BE SLIGHTLY HIGHER THAN THOSE OF SHT. 2.20), THE PROCESS WILL HAVE CONVERGED ENOUGH TO GIVE A REASONABLY ACCURATE PICTURE LOAD DISTRIBUTION FOR THE LOADING OF ASSUMPTION (2), SHT. 0.1.

AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT:		REPORT NO. 7/0558/67	
C 105	AIR VENTS	SHEET NO 0.4	
		PREPARED BY	DATE
		KAUTT	5/29/56
		CHECKED BY	DATE

CONCLUSIONS & RECOMMENDATIONS (CONT.)

THE SHEAR DEFLECTION OF STN 678.05 RELATIVE TO STN 668.45 UNDER THE LOADING OF ASSUMPTION (2) SHT. 0.2, WAS FOUND TO BE .096" (REF. SHT. 2.3), USING A REDUCED SHEAR MODULUS BECAUSE OF THE BUCKLED CONDITION OF THE SKIN. SINCE THIS IS LESS THAN THE DEFLECTION OF .117" CALCULATED FOR THE TRUSS, IT WOULD APPEAR THAT THE TRUSS DOES NOT PICK UP AS MUCH LOAD AS ASSUMPTION (2) SHT. 0.1 SHOWS. THUS THE TRUSS WILL VERY PROBABLY NOT FAIL UNDER THE LOADS IT WILL PICK UP. HOWEVER, THIS MEANS THAT THE SKIN PANELS ABOVE & BELOW THE TRUSS WILL BE CARRYING MORE THAN THE ASSUMED 1600 #/" SHEAR FLOW, & THAT FRAMES AT STN 668.45 & STN 678.05 WILL PICK UP SOME AXIAL LOAD DUE TO THE REDISTRIBUTION OF SHEAR FLOW.

SINCE IT IS VERY DIFFICULT TO DETERMINE THE SHEAR DEFLECTION OF THE SKIN BETWEEN STN 678.05 & STN 668.45 BECAUSE OF DIFFICULTY IN OBTAINING AN ACCURATE VALUE FOR THE SHEAR MODULUS, THE FOLLOWING RECOMMENDATIONS ARE MADE:

1) STEPS (A), (B), & (C) OF SHT. 0.2 BE CARRIED OUT.

2) THE STRESSING OF SECTION I BE DONE WITH THE LOADS OBTAINED FROM (1), TAKING INTO ACCOUNT BENDING, AS WELL AS AXIAL LOADS. THIS WILL DETERMINE WHETHER THE TRUSS IS ADEQUATE FOR THE LOADING OF ASSUMPTION (2) SHT. 0.1.

3) THE STRESSES IN THE AREA OF THE VENTS BE OBTAINED BY STRAIN GAGE MEASUREMENTS DURING STATIC TEST OF THE AIRCRAFT.

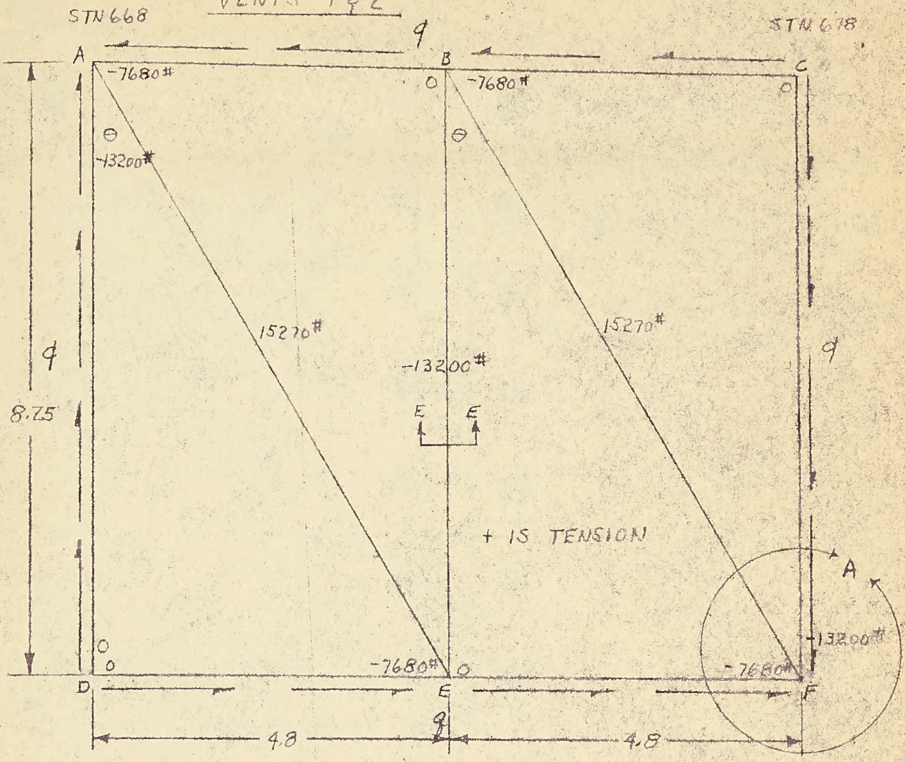
FORM 1319A

A. V. ROE CANADA LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7-0558-67
SHEET NO. 1.1

AIRCRAFT:		PREPARED BY	DATE
C 105	ONE WAY COOLING AIR VALVES DWG 7-0158-353	E. KANTT	1/25/56
		CHECKED BY	DATE

VENTS 1 & 2



THE STRUCTURE AROUND THE ONE-WAY COOLING AIR VENTS IS CONSIDERED TO BE A PIN-ENDED TRUSS LOADED BY THE SHEAR FLOWS q AS SHOWN IN THE ABOVE SKETCH. $q = 1600\#/''$

TRUSS MEMBER LOADS $\theta = TAN^{-1}\frac{4.8}{8.25} = 30.2^\circ$

MEMBER CF
THE LOAD IN CF VARIES FROM 0 AT C TO $8.25q = 13200\#$ (COMP) AT F

MEMBER EF
THE LOAD IN EF VARIES FROM 0 AT E TO $4.8q = 7680\#$ (COMP) AT F

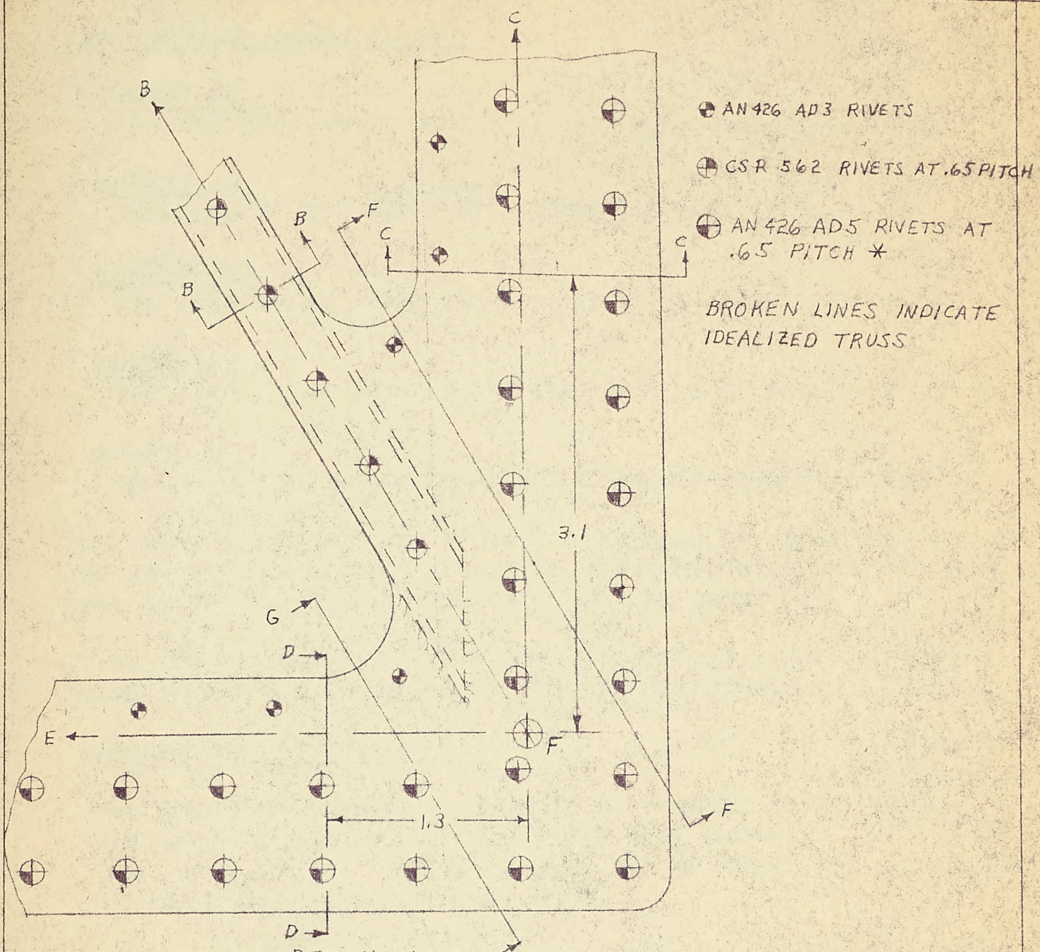
MEMBER BF
THE LOAD IN BF $= \sqrt{(13200)^2 + (7680)^2} = 15270\#$ (TENS)

MEMBER BE
THE LOAD IN MEMBER $BE = BF\cos\theta = 13200\#$ (COMP)

FORM 1319A

A. V. ROE CANADA LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT (Aircraft)

REPORT No. 7/0558/67	SHEET No. 12		
AIRCRAFT: C 105	ONE-WAY COOLING AIR VENTS DWG 7-0158-353	PREPARED BY E. KNUTT	DATE 1/26/56
		CHECKED BY	DATE



DETAIL A

LOAD AT SECTION C-C = 13200 - 3.1 × 1600 = 8240#

LOAD AT SECTION D-D = 7680 - 1.3 × 1600 = 5600#

*NOTE: RIVETS HAVE BEEN CHANGED TO CSR 124 (SMALL HEAD) WHICH HAVE THE SAME SHEAR ALLOWABLE, BUT HIGHER ALLOWABLE WHEN C'SUNK IN .064 75-ST6. THEREFORE, THE FOLLOWING RIVET ANALYSIS IS CONSERVATIVE.

FORM 1319A

A. V. ROE CANADA LIMITED MALTON - ONTARIO **TECHNICAL DEPARTMENT (Aircraft)**		REPORT No. 7/0558/67 SHEET No. 13	
AIRCRAFT: C105	ONE-WAY COOLING AIR VENTS DWG. 7-0158-353	PREPARED BY	DATE 1/26/56
		CHECKED BY	DATE

TRUSS MEMBER LOADS (CONT)

MEMBER DE

THE LOAD IN DE VARIES FROM 0 AT D TO 4.8q = 7680# (COMP) AT E

MEMBER AE

THE LOAD IN AE $= \sqrt{DE^2 + BE^2} = 15270$# (TENS)

MEMBER DA

THE LOAD IN DA VARIES FROM 0 AT D TO 13200# (COMP) AT A

MEMBER AB

THE LOAD IN AB VARIES FROM 0 AT B TO 4.8q = 7680# (COMP) AT A.

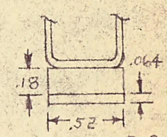
MEMBER BC

THE LOAD IN BC VARIES FROM 0 AT C TO 4.8q = 7680# (COMP) AT B

THE ABOVE LOADS ARE FOR A DOWN SHEAR FLOW OF 1600#/" AT STN 678. FOR AN UP SHEAR FLOW OF 1600#/", THE MAGNITUDES OF THE LOADS WILL BE THE SAME, BUT THE SIGNS WILL BE REVERSED.

SINCE THE STRUCTURE & LOADS ARE SYMMETRICAL, ONLY THE RIGHT-HAND SIDE (BOUNDED BY BCFE) WILL BE INVESTIGATED.

MEMBER BF (SECTION B-B)



SECTION B-B

THE DIAGONAL MEMBER DF, CONSISTS OF A STEEL PLATE .18" THICK x .52" WIDE RIVETED TO THE SKIN, WHICH IS .064" " x .52" " 75S-T6 AL ALLOY, BY 1/8 MONEL CHERRY RIVETS AT .65" PITCH.

IT IS ASSUMED THAT THE STEEL & ALUMINUM HAVE EQUAL STRAINS. THEREFORE:

$$\frac{P_A}{t_A E_A} = \frac{P_S}{t_S E_S} \quad \text{OR,} \quad P_S = \frac{t_S E_S P_A}{t_A E_A}$$

$t_s = .180"$, $t_A = .064"$, $E_s = 29 \times 10^6$ PSI, $E_A = 10.5 \times 10^6$ PSI

$$P_s = \frac{.18 \times 29 \times 10^6 P_A}{.064 \times 10.5 \times 10^6} = 7.76786\, P_A$$

SINCE $P_s + P_A = 15270$#, $8.76786\, P_A = 15270$ &

$$P_A = \frac{15270}{8.76786} = 1742\text{\#} \quad \& \quad P_s = 7.76786 \times 1742 = 13528\text{\#}$$

RM 1319A

A. V. ROE CANADA LIMITED MALTON - ONTARIO **TECHNICAL DEPARTMENT (Aircraft)**		REPORT No. 7/0558/67 SHEET No. 1.4	
AIRCRAFT: C 105	ONE-WAY COOLING AIR VENTS DWG 7-0158-353	PREPARED BY K. Avitt	DATE 1/26/56
		CHECKED BY	DATE

MEMBER BF (CONT.)

THE NET AREA ACROSS A RIVET HOLE IN BF IS:

$A_{ST} = (.52 - .1285)(.18) = .07047 \text{ in}^2$

$A_{AL} = (.52 - .1285)(.064) = .025056 \text{ in}^2$

STRESS IN STEEL:

$f_{ST} = \frac{13528}{.07047} = 192000 \text{ PSI}$

$F_{tu} = 180000 \text{ PSI}$ $\qquad MS = \frac{180000}{192000} - 1 = \underline{\underline{-.06}}$

STRESS IN ALUM.

$f_{AL} = \frac{1742}{.025056} = 69530 \text{ PSI}$

$F_{tu} = 72000 \text{ PSI}$ $\qquad MS = \frac{72000}{69530} - 1 = \underline{\underline{.03}}$

MEMBER BF HAS AN .051 75S-T6 CHANNEL ATTACHED BY 1/8 MONEL CHERRY RIVETS. THIS CHANNEL PROVIDES A PLACE TO ATTACH THE DOORS, & ALSO STIFFENS THE MEMBER. ALTHO IT IS CLIPPED TO THE FRAMES AT B & F, IT DOES NOT PICK UP END LOAD DIRECTLY. AS BF DEFLECTS UNDER LOAD, THE CHANNEL WILL PICK UP LOAD THRU THE RIVETS ATTACHING IT. A 1/8 CHERRY MONEL IN .051 CAN TRANSMIT 660# (REF ANC-5). THERE ARE 3 RIVETS BEFORE SECTION B-B. THUS THE TOTAL LOAD IN BF AT SECTION B-B WILL BE

$P = 15270 - (3)(660) = 13290\#$

$P_{AL} = \frac{13290}{8.76786} = 1516\#$ $\qquad P_{ST} = 7.76786 \times 1516 = 11774\#$

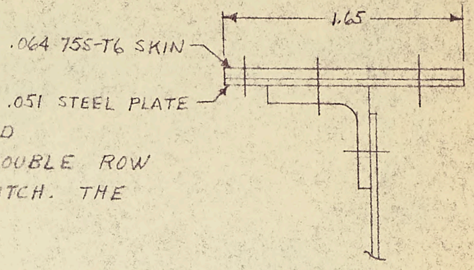
$f_{ST} = \frac{11774}{.07047} = 167000 \text{ PSI}$ $\qquad MS = \frac{180000}{167000} - 1 = \underline{\underline{.07}}$

$f_{AL} = \frac{1516}{.025056} = 60500 \text{ PSI}$ $\qquad MS = \frac{72000}{60500} - 1 = \underline{\underline{.19}}$

FORM 1319 A

MEMBER CF (SECTION C-C)

THE VERTICAL MEMBER CF CONSISTS OF THE .064 75-ST6 SKIN & .051 STEEL PLATE, WHICH ARE CONNECTED & ATTACHED TO THE FRAME BY MEANS OF A DOUBLE ROW OF AN426 AD5 RIVETS AT .65" PITCH. THE .064 SKIN IS C'SUNK.



SECTION C-C

MAKING THE SAME ASSUMPTION AS AT SECT. B-B, THE LOAD DISTRIBUTION IS AS FOLLOWS:

$$P_{ST} = \frac{.051 \times 29 \times 10^6 P_{AL}}{.064 \times 10.5 \times 10^6} = 2.201 P_{AL}$$

$P_{ST} + P_{AL} = -8240^{\#}$ REF. SHT 2

$$P_{AL} = \frac{8240}{3.201} = -2574^{\#} \qquad P_{ST} = 2.201 \times 2574 = -5666^{\#}$$

$$A_{ST} = 1.65 \times .051 = .0841''^2$$
$$A_{AL} = 1.65 \times .064 = .1056''^2$$

$$f_{ST} = \frac{5666}{.0841} = 67400 \text{ PSI} \qquad f_{AL} = \frac{2574}{.1056} = 24400 \text{ PSI}$$

FROM LOCKHEED RPT 2072; FOR .064 75S-T6 SHT AT $\frac{s}{t} = \frac{.65}{.064} = 10.1$,

$$F_{cr} = 63000 \text{ PSI} \qquad MS = \frac{63000}{24400} - 1 = \underline{\underline{1.56}}$$

& FOR .051 STEEL SHT AT $\frac{s}{t} = \frac{.65}{.051} = 12.7$

$$F_{cr} = 147000 \text{ PSI} \qquad MS = \frac{147000}{67400} - 1 = \underline{\underline{1.28}}$$

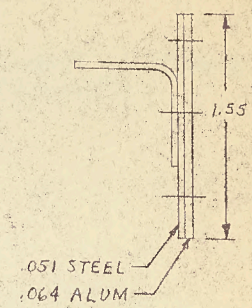
A. V. ROE CANADA LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7/0558/67
SHEET NO. 16

AIRCRAFT:		PREPARED BY	DATE
C 105	ONE WAY COOLING AIR VENTS DWG 7-0158-353	KNOTT	1/26/56
		CHECKED BY	DATE

MEMBER EF (SECTION D-D)

THE HORIZONTAL MEMBER EF CONSISTS OF THE .064 75S-T6 SKIN & .051 STEEL PLATE, WHICH ARE CONNECTED BY TWO ROWS OF AN 426 AD5 RIVETS AT .65" PITCH.



SECTION D-D

MAKING THE SAME ASSUMPTION AS FOR SECTION B-B:

$P_{ST} = 2.201 P_{AL}$ (REF. SHT. 5)

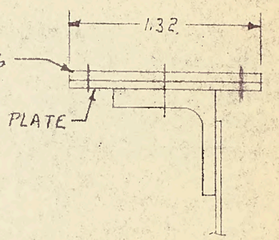
$P_{ST} + P_{AL} = -5600\#$ (REF. SHT. 2)

$P_{AL} = \frac{-5600}{3.201} = -1750\#$ $\qquad P_{ST} = 2.201 \times -1750 = -3850\#$

SECTION D-D IS OK BY COMPARISON TO SECT. C-C, SHT 5

MEMBER BE (SECTION E-E)

THE VERTICAL MEMBER, BE, CONSISTS OF THE .064 75S-T6 SKIN & .051 STEEL PLATE, WHICH ARE CONNECTED & ATTACHED TO THE FRAME BY AN426-AD5 RIVETS AT .65" PITCH.



SECTION E-E

USING THE SAME ASSUMPTION AS IN D-D, ABOVE,

$P_{ST} = 2.201 P_{AL}$

$P_{ST} + P_{AL} = -13200\#$ (REF. SHT. 3)

$P_{AL} = \frac{-13200}{3.201} = -4124\#$ $\qquad P_{ST} = 2.201(-4124) = -9076\#$

$A_{ST} = 1.32 \times .051 = .0673''^2$
$A_{AL} = 1.32 \times .064 = .0845''^2$

$f_{ST} = \frac{-9076}{.0673} = -135000$ PSI $\qquad F_{cr} = 147000$ PSI (REF. SHT. 5)

$MS = \frac{147000}{135000} - 1 = \underline{.09}$

$f_{AL} = \frac{-4124}{.0845} = -48800$ PSI $\qquad F_{cr} = 63000$ PSI (REF. SHT. 5)

$MS = \frac{63000}{48800} - 1 = \underline{.29}$

FORM 1319A

A. V. ROE CANADA LIMITED MALTON - ONTARIO **TECHNICAL DEPARTMENT (Aircraft)**		REPORT No. 7/0558/67 SHEET No. 17	
AIRCRAFT: C 105	ONE WAY COOLING AIR VENTS DWG 7-0158-353	PREPARED BY E. KAUTT	DATE 1/26/56
		CHECKED BY	DATE

MEMBER BE (TENSION CASE)

WHEN MEMBER BE IS IN TENSION, THE AREA MUST BE REDUCED BY THE AREA OF THE HOLE FOR AN AD 426 AD5 RIVET.

$$A_{ST} = (1.32 - .159)(.051) = .0592''^2$$

$$A_{AL} = (1.32 - .159)(.064) = .0742''^2$$

$P_{ST} = 9076$ (REF. SHT. 6)

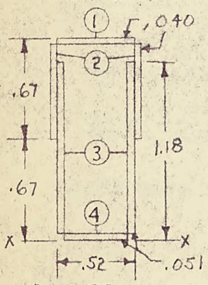
$$f_{ST} = \frac{9076}{.0592} = 153000 \text{ PSI} \qquad MS = \frac{180000}{153000} - 1 = \underline{\underline{.17}}$$

$P_{AL} = 4124^{\#}$ (REF. SHT. 6)

$$f_{ST} = \frac{4124}{.0742} = 55600 \qquad MS = \frac{72000}{55600} - 1 = \underline{\underline{.29}}$$

MEMBER BF (COMPRESSION CASE)

THE DIAGONAL MEMBER BF, IS ATTACHED TO A BOX BEAM WHICH, ALTHO IT DOESN'T TAKE END LOAD, DOES STABILIZE BF WHEN BF IS IN COMPRESSION. THIS IS CHECKED BY THE METHOD IN "THEORY OF ELASTIC STABILITY" BY TIMOSHENKO, 1936, SHTS 108-111. THE BOX BEAM IS MADE UP OF AN .040 & AN .051 75S-T6 CHANNEL.



BOX BEAM

ITEM	A	Y	AY	AY²	I_o
1	.0208	1.32	.0274	.0362	——
2	.0504	.96	.0484	.0464	.0017
3	.1152	.64	.0737	.0472	.0123
4	.0214	.03	.0064	.0002	——
Σ	.2078	——	.1559	.1300	.0140

$$\bar{Y} = \frac{.1559}{.2078} = .75'' \qquad I = .1440 - .1170 = .027''^4$$

$L = 7.7''$ $E = 10.5 \times 10^6$ PSI

$$\alpha = \frac{384EI}{5L^3} = \frac{(384)(10.5)(10^6)(.027)}{(5)(7.7)^3} = 47690$$

CONSIDERING THE .064 75-ST6 TO BE EQUIVALENT TO .02" OF STEEL, THE I OF SECT. B-B IS:

$$I = \frac{.52 \times (.02)^3}{12} = .000347''^4$$

ORM 1319A

A. V. ROE CANADA LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT (Aircraft)

REPORT No. 7/0558/67
SHEET No. 18

AIRCRAFT:		PREPARED BY	DATE
C 105	ONE WAY COOLING AIR VALVES DWG 7-0158-353	E. KNOTT	1/26/55
		CHECKED BY	DATE

MEMBER BF (CONT.)

$\beta = \frac{\alpha}{a} = \frac{47690}{7.7} = 6195$

$\frac{\beta l^4}{16EI} = \frac{(6195)(7.7)^4}{(16)(29)(10^6)(.000347)} = 135$

$L/l = .328$

$L = .328 \times 7.7 = 2.52''$

$P_{cr} = \frac{\pi^2 EI}{L^2} = \frac{\pi^2 (29)(10^6)(.000347)}{(2.52)^2} = 15630\#$

$P = 15270\#$ (COMP) REF SHT 3

$MS = \frac{15630}{15270} - 1 = \underline{\underline{.025}}$

IN THE ABOVE ANALYSIS, NO CONSIDERATION WAS TAKEN OF THE AMOUNT OF FIXITY AT THE ENDS, NOR OF A POSSIBLE FURTHER REDUCTION IN THE LENGTH.

COMPRESSION STRESS IN BF

$A_{ST} = (.52)(.18) = .0936''^2$
$A_{AL} = (.52)(.064) = .0333''^2$

$P_{ST} = -13528\#$ (REF. SHT. 3)
$P_{AL} = -1742\#$ (" " 3)

$f_{ST} = \frac{-13528}{.0936} = -144500$ PSI

$f_{AL} = \frac{-1742}{.0333} = -52400$ PSI

INTER RIVET BUCKLING STRESS FOR AL = 63000 PSI (REF. SHT. 5)

$MS = \frac{63000}{52400} - 1 = \underline{\underline{.20}}$

FORM 1319A

A. V. ROE CANADA LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT (Aircraft)

AIRCRAFT:		REPORT NO. 7/0558/67	
C 105	ONE WAY COOLING AIR VALVES DWG 7-0158-353	SHEET NO. 49	
		PREPARED BY: E. KANTT	DATE: 1/27/56
		CHECKED BY	DATE

SECTION F-F (SHT. 2)

THE .064 ALUM IS EQUIVALENT TO $.064 \times \frac{10.5}{29} = .023''$ THICK STEEL.
THICKNESS OF EQUIVALENT STEEL PLATE = .051 + .023 = .074"

EQUIVALENT AREA = $.074 \times 3.65 = .270''^2$

SHEAR ON SECT. F-F = CF COSθ = 13200 COS 30.2° = 11400#

TENSION ON SECT. F-F = CF SINθ = 6650#

$f_s = \frac{11400}{.27} = 42200$ PSI $f_t = \frac{6650}{.27} = 24600$ PSI

$F_{SU} = 109000$ PSI $F_{tu} = 180000$ PSI

$R_s = \frac{42200}{109000} = .387$ $R_t = \frac{24600}{180000} = .137$

* USING INTERACTION FORMULA OF $R_t^{2.2} + R_s^{2.2} = 1$,

$MS = \frac{.35}{.137} - 1 = 1.55$

SHEAR IN ALUM = $42200 \times \frac{.023}{.064} = 15200$ PSI

TENSION IN ALUM = $24600 \times \frac{.023}{.064} = 8830$ PSI

* FROM LOCKHEED SM 70a FIG. 8

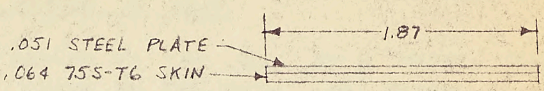
FORM 1319A

A. V. ROE CANADA LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT (Aircraft)

REPORT No. 7/0558/67
SHEET No. 1.10

AIRCRAFT:		PREPARED BY	DATE
C 105	ONE WAY COOLING AIR VENTS	E. KAUTT	1/27/56
		CHECKED BY	DATE

SECTION G-G (SHT. 2)



THIS SECTION IS CHECKED IN THE SAME MANNER AS SECT. F-F (SHT. 9)

EQUIVALENT AREA = $.074 \times 1.87 = .1385 \text{ in}^2$

SHEAR ON SECT G-G = $EF \sin\theta = 7680 \sin\theta = 3870$#
TENSION ON SECT G-G = $EF \cos\theta = 6650$#

$f_s = \frac{3870}{.1385} = 28000$ PSI $\qquad f_t = \frac{6650}{.1385} = 48000$ PSI

*$R_s = \frac{28}{109} = .257$ $\qquad$ *$R_t = \frac{48}{180} = .267$

*$MS = \frac{.74}{.267} - 1 = \underline{1.77}$

* SEE SHT. 9

FORM 1319A

A. V. ROE CANADA LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT (Aircraft)

REPORT No. 7/0558/67
SHEET No. 1.11

AIRCRAFT:		PREPARED BY	DATE
C 105	ONE WAY COOLING AIR VENTS DWG 7-0158-353	KAUTT	1/27/56
		CHECKED BY	DATE

ATTACHMENT OF STEEL PLATE TO SKIN

THE STEEL PLATE IS ATTACHED TO THE SKIN BY A DOUBLE ROW OF AN 426 AD 5* RIVETS C'SUNK IN THE SKIN. .65" PITCH.

ASSUMING THE DISTRIBUTION OF LOAD BETWEEN SKIN & PLATE TO BE THAT SHOWN ON SHEET 5, THE AMOUNT OF LOAD TRANSFERRED TO THE STEEL PLATE IS:

$$q_{ST} = \frac{2.201}{3.201}(1600) = 1100 \ \#/"$$

THIS IS THE AMOUNT OF SHEAR FLOW TRANSFERRED TO THE STEEL PLATE BY THE RIVETS FROM THE SKIN.

$$\text{LOAD / RIV} = \frac{1100 \times .65}{2} = 357^{\#}$$

ALLOWABLE LOAD OF AN426 AD5 RIVET IN C'SUNK .064 75S-T6 = 523#
(REF. ANC-5)

$$MS = \frac{523}{357} - 1 = .46$$

* SEE NOTE, SHT. 2

FORM 1319A

A. V. ROE CANADA LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT (Aircraft)

REPORT No. 7/0558/67
SHEET No. 1.12

AIRCRAFT:		PREPARED BY	DATE
C 105	ONE WAY COOLING AIR VENTS DWG. 7-0158-353	KRUTT	1/27/56
		CHECKED BY	DATE

DETAIL A (SHT. 2)

LOAD IN STEEL AT SECTION B-B = 13528# (REF. SHT. 3)
" " " " " C-C = 5666# (" " 5)
" " " " " D-D = 3850# (" " 6)

COMPONENT OF LOAD AT C-C IN DIRECTION OF BF = $P_{S_{CF}}$

$P_{S_{CF}} = 5666 \cos 30.2° = 4900$#

COMPONENT OF LOAD AT D-D IN DIRECTION OF BF = $P_{S_{EF}}$

$P_{S_{EF}} = 3850 \sin 30.2° = 1940$#

$P_{S_{CF}} + P_{S_{EF}} = 4900 + 1940 = 6840$#

THIS MEANS THAT 13528 - 6840 = 6686# MUST BE TRANSFERRED FROM THE .064 ALUM. SKIN TO THE STEEL PLATE IN THE AREA BOUNDED BY SECTIONS B-B, C-C, & D-D. IN THIS AREA THERE ARE 16 AN 426 AD5* RIVETS.

ALLOWABLE LOAD = 16 × 523 = 8368# (REF. SHT. 11)

$$MS = \frac{8368}{6686} - 1 = \underline{.25}$$

* SEE NOTE, SHT. 2

FORM 4319A

A. V. ROE CANADA LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT (Aircraft)

REPORT No. 7/0558/67			
SHEET No. 1.13			
AIRCRAFT: C 105	ONE WAY COOLING AIR VALVES DWG 7-0158-353	PREPARED BY: KAUTT	DATE: 1/27/56
		CHECKED BY	DATE

LOCAL INSTABILITY OF MEMBER BE

ASSUMING THE .051 STEEL PLATE & .064 SKIN WORK TOGETHER IN RESISTING COMPRESSION IN LOCAL INSTABILITY, THE EQUIVALENT THICKNESS OF STEEL = .074" (REF. SHT. 9). THIS EQUIVALENT SECTION IS CONSIDERED TO BE SIMPLY SUPPORTED AT THE RIVET LINE IN THE CENTER OF THE SHEET.

FROM RAeS DATA SHEET 01.01.08, $f_{cr} = .58\, E_t \left(\frac{t}{d}\right)^2$

$E_t = 22 \times 10^6$ PSI
$t = .074"$
$d = 1.32/2 = .66"$ (REF. SHT. 6)

$$f_{cr} = (.58)(22)(10^6)\left(\frac{.074}{.66}\right)^2 = 160{,}000 \text{ PSI}$$

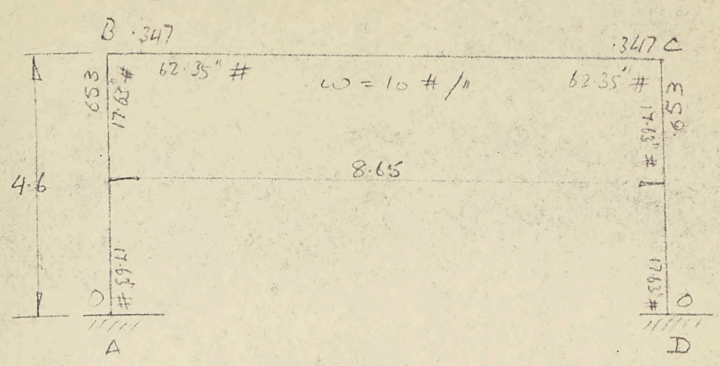
THIS VALUE IS GREATER THAN THAT FOR INTER RIVET BUCKLING (REF. SHT. 6). LOCAL INSTABILITY NOT CRITICAL.

FORM 1319A

AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT: C.105	PRESSURE VENT Nos. 1 AND 2.	REPORT No. 7/0558/67	SHEET No. 1.14
		PREPARED BY: E. KAUTT	DATE: 2/19/56
		CHECKED BY:	DATE:

DRG 7-0158-270 ? -353 ?



AB AND CD : RSF = $\frac{1}{4.6}$ = .2174

BC : RSF = $\frac{1}{8.65}$ = $\frac{.1156}{.333}$

DF AB AND CD = $\frac{.2174}{.333}$ = .653 D.F. BC = $\frac{.1156}{.333}$ = .347

F.E.M. AB AND CD = $\frac{\omega L^2}{12} = \frac{(10)(4.6)^2}{12}$ = 17.63" #

F.E.M. BC = $\frac{(10)(8.65)^2}{12}$ = 62.35" #

CLOCKWISE M IS POSITIVE.

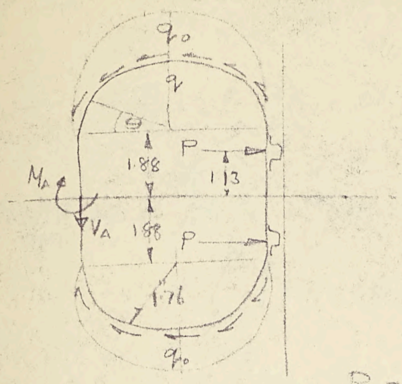
JOINT	A	B		C		D
C.O.F.	.5	.5	.5	.5	.5	.5
D.F.	0	.653	.347	.347	.653	0
F.E.M.	17.63	-17.63	62.35	-62.35	17.63	-17.63
	0	-29.2	-15.52	+15.52	29.2	0
	-14.6	0	7.76	-7.76	0	14.6
	0	-5.07	-2.69	2.69	5.07	0
	-2.54	0	1.35	-1.35	0	2.54
	0	-.88	-.47	.47	.88	0
	-.44	0	+.23	-.23	0	.44
	0	-.15	-.08	.08	.15	0
	-.08	0	.04	-.04	0	.08
	0	-.03	-.01	.01	.03	0
	-.03	-52.96	52.96	-52.96	52.96	.03

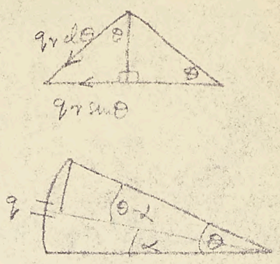
FORM 1319 A

AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

REPORT No.	7/0555R/67
SHEET No	1.15

AIRCRAFT:		PREPARED BY	DATE
C.105	PRESSURE VENT	R. WADE.	
		CHECKED BY	DATE





$$q = q_0 \sin\theta$$

$$P = \int_0^{\pi} q_0 r \, d\theta \sin^2\theta = \left[q_0 r \left(\frac{\theta}{2} - \frac{\sin 2\theta}{4} \right) \right]_0^{\pi}$$

$$= q r \frac{\pi}{2} - 0 = \frac{\pi}{2} q_0 r$$

$$q_0 = \frac{2P}{\pi r}$$

① $\dfrac{AB}{0 < x < 1.88}$ $\qquad M = M_A$

② $\dfrac{BC}{0 < \theta < \pi}$ $\qquad M_\theta = M_A - V_A r (1 - \cos\theta)$

$$- q_0 r^2 \int_0^{\theta} \sin\alpha \left[1 - \cos(\theta - \alpha) \right] d\alpha .$$

$$= M_A - V_A r (1 - \cos\theta) - q_0 r^2 \int_0^{\theta} \sin\alpha \left[1 - \cos\theta \cos\alpha - \sin\theta \sin\alpha \right] d\alpha .$$

$$= M_A - V_A r (1 - \cos\theta) - q_0 r^2 \int_0^{\theta} \left(\sin\alpha - \cos\theta \sin\alpha \cos\alpha - \sin\theta \sin^2\alpha \right) d\alpha .$$

$$= M_A - V_A r (1 - \cos\theta) - q_0 r^2 \left[-\cos\alpha - \cos\theta \frac{\sin^2\alpha}{2} - \sin\theta \left(\frac{\alpha}{2} - \frac{\sin 2\alpha}{4} \right) \right]_0^{\theta}$$

$$= M_A - V_A (r - r\cos\theta) - q_0 r^2 \left[-\cos\theta + 1 - \cos\theta \frac{\sin^2\theta}{2} - \sin\theta \left(\frac{\theta}{2} - \frac{\sin 2\theta}{4} \right) \right]$$

$$= M_A - V_A (r - r\cos\theta) - q_0 r^2 \left[1 - 2\cos\theta - \frac{\theta}{2} \sin\theta \right] .$$

CD

③ $1.88 > x > 1.13$ $\qquad M_x = M_A - 2V_A r - 3 q_0 r^2 - P(1.88 - x)$

DE

④ $1.13 > x > 0$ $\qquad M_x = M_A - 2V_A r - 3 q_0 r^2 - .75\,P$

CONTINUED:-

FORM 1319A

AVRO AIRCRAFT LIMITED
MALTON · ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT:		REPORT No. 7/0358/67.
C.105	PRESSURE VENT	SHEET No. 1.13.
		PREPARED BY: R. WADE. — DATE:
		CHECKED BY: — DATE:

① AB $\frac{\partial M}{\partial M_A} = 1 \quad \frac{\partial M}{\partial V_A} = 0$

② BC $\frac{\partial M}{\partial M_A} = 1 \quad \frac{\partial M}{\partial V_A} = -r(1-\cos\theta)$

③ CD $\frac{\partial M}{\partial M_A} = 1 \quad \frac{\partial M}{\partial V_A} = -2r$

④ DE $\frac{\partial M}{\partial M_A} = 1 \quad \frac{\partial M}{\partial V_A} = -2r$

① $$\frac{\partial U}{\partial M_A} EI = \int_0^{1.88} M_A\,dx + \int_0^{\pi}\left\{M_A - V_A r(1-\cos\theta) - q_0 r^2\left(1 - 2\cos\theta - \tfrac{\theta}{2}\sin\theta\right)\right\}d\theta$$
$$+ \int_{1.13}^{1.88}\left\{M_A - 2V_A r - 3q_0 r^2 - P(1.88 - x)\right\}dx$$
$$+ \int_0^{1.13}\left\{M_A - 2V_A r - 3q_0 r^2 - .75P\right\}dx$$

① $$\frac{\partial U}{\partial V_A} EI = \int_0^{\pi} -\left\{M_A - V_A r(1-\cos\theta) - q_0 r^2\left(1 - 2\cos\theta - \tfrac{\theta}{2}\sin\theta\right)r(1-\cos\theta)\right\}d\theta$$
$$+ \int_{1.13}^{1.88} -\left\{M_A - 2V_A r - 3q_0 r^2 - P(1.88 - x)\right\}2r\,dx.$$
$$+ \int_0^{1.13} -\left\{M_A - 2V_A r - 3q_0 r^2 - .75P\right\}2r\,dx.$$

$\therefore$ ① $$1.88M_A + \pi M_A - \pi V_A r - q_0 r^2\pi + 2q_0 r^2\pi + .75M_A$$
$$- 1.5V_A r - 2.25q_0 r^2 - 1.41 + .281P + 1.13M_A$$
$$- 2.26V_A r - 3.39q_0 r^2 - .8475P = 0$$

AND $6.9M_A - 12.15V_A - 10.75P = 0$ ——— (A)

② $$-\pi r M_A + \pi r^2 V_A + \frac{\pi}{2}V_A r^2 + 2Pr^2\pi + 4Pr^2\frac{\pi}{2} - 2P_1 r^2\pi$$
$$+ Pr^2\frac{\pi}{4} - 2.64M_A + 5.26V_A r + 7.9q_0 r^2 + 4.95P_1$$
$$- .988P_1 - 3.97M_A + .795V_A r + 11.91q_0 r^2 + 2.98P = 0$$

AND $-12.14M_A + 37.87V_A + 98.76P = 0$ ——— (B).

$12.14M_A - 21.4V_A - 18.91P = 0$

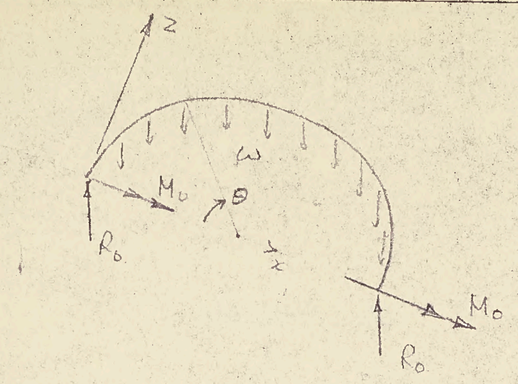
$+16.47V_A + 79.85P = 0$

$\therefore V_A = -4.85P \quad M_A = -6.83P$

Continued :—

AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT:		REPORT No. 7/0558/67	
		SHEET No. 1.17	
C-105	PRESSURE VENT	PREPARED BY	DATE
		R. WADE	
		CHECKED BY	DATE



$$R_0 = \frac{\omega \pi r}{2}$$

$$M_{0_{xx}} = \frac{1}{2}\int_0^{\pi} \omega r^2 d\theta \sin\theta = \frac{1}{2}\omega r^2\left[-\cos\theta\right]_0^{\pi}$$

$$= \frac{1}{2}\omega r^2\left[1+1\right] = \underline{\omega r^2}$$

$$M_{\theta_{xx}} = M_0 - R_0 r \sin\theta + \int_0^{\theta} \omega r^2 d\alpha\left(\sin\theta - \sin\alpha\right)$$

$$= \omega r^2 - \frac{\pi}{2}\omega r^2 \sin\theta + \omega r^2\left[\alpha \sin\theta + \cos\alpha\right]_0^{\theta}$$

$$= \omega r^2\left\{1 - \frac{\pi}{2}\sin\theta + \theta\sin\theta + \cos\theta - 1\right\}.$$

$$= \omega r^2\left\{\sin\theta\left(\theta - \frac{\pi}{2}\right) + \cos\theta\right\}.$$

$$M_{\theta_{zz}} = R_0 r\left(1 - \cos\theta\right) - \int_0^{\theta}\omega r^2 d\alpha\left(\cos\alpha - \cos\theta\right)$$

$$= \frac{\pi}{2}\omega r^2\left(1 - \cos\theta\right) - \omega r^2\left[\sin\alpha - \alpha\cos\theta\right]_0^{\theta}$$

$$= \omega r^2\left\{\frac{\pi}{2} - \frac{\pi}{2}\cos\theta - \sin\theta + \theta\cos\theta\right\}.$$

$$= \omega r^2\left\{1 + \frac{\pi}{2} + \cos\theta\left\{\theta - \frac{\pi}{2}\right\} - \sin\theta\right\}.$$

AT $\theta = \pi/2$ $\quad M_{\theta_{xx}} = \omega r^2\left\{1\left(\frac{\pi}{2} - \frac{\pi}{2}\right) + 0\right\} = 0$

$$M_{\theta_{zz}} = \omega r^2\left\{1 + \frac{\pi}{2} + 0 - 1\right\}. = \underline{\frac{\pi}{2}\omega r^2}$$

SECTION DEPTH $= 5.0''$ $\quad t = .032$ $\quad Z = \frac{5.0^2 \times .032}{6} = .133\ \text{in}^3$

$$f_b = \frac{\frac{\pi}{2}\cdot 33 \cdot 1.76}{.133} = \underline{685\ \text{lb/in}^2}$$

FORM 1319A

SECTION 2

DEFLECTION OF STRUCTURE

&

INDUCED TRUSS MOMENTS

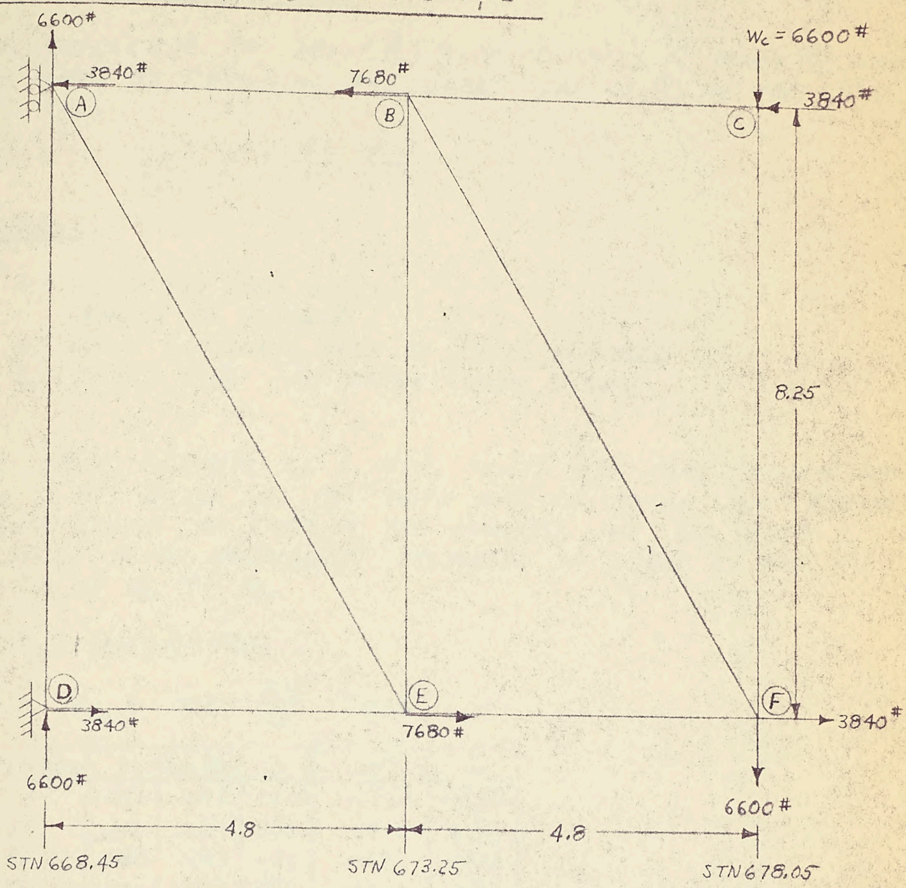
VENTS 1 & 2

DWG 7-1058-5075/76

A. V. ROE CANADA LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT (Aircraft)

AIRCRAFT: C 105	ONE WAY COOLING AIR VALVES DWG 7-0158-353	REPORT NO. 7/0558/67	SHEET NO. 2.1
		PREPARED BY: E. KAUTT	DATE: 1/31/56
		CHECKED BY:	DATE:

DEFLECTION OF TRUSS VENTS 1 & 2



ASSUMPTIONS:

1) TRUSS IS PIN-JOINTED

2) POINT (D) IS FIXED IN SPACE

3) POINT (A) IS FREE TO DEFLECT VERTICALLY

PROBLEM:

TO FIND THE VERTICAL DEFLECTION OF POINT (C) WITH RESPECT TO POINT (D). $= \Delta C$

A. V. ROE CANADA LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7/0558/67
SHEET NO. 2.2

AIRCRAFT:		PREPARED BY	DATE
C 105	ONE-WAY COOLING AIR VALVES DWG 7-0158-353	E. KAUTT	1/31/56
		CHECKED BY	DATE

TRUSS DEFLECTIONS (CONT)

THE DEFLECTION OF POINT (C) WITH RESPECT TO POINT (D) MAY BE FOUND BY REPLACING THE 6600# LOAD AT (C) BY THE LOAD W_c. THEN

$$\Delta C = \frac{1}{E} \sum \frac{P_o L}{A} \cdot \frac{\partial P_o}{\partial W_c}$$

WHERE:

$E = 29 \times 10^6$ PSI (FOR STEEL)
L = LENGTH OF MEMBER
A = CROSS SECTIONAL AREA OF TRUSS MEMBER
$P_o = f(W_c) + f(P_n)$ P_n = OTHER LOADS SHOWN

THE TRUSS CONSISTS OF A STEEL PLATE .051" THICK (EXCEPT FOR AE & BF WHICH ARE .180" THICK) RIVETED TO AN .064" 75S-T6 ALUM. SHEET. TO SIMPLIFY THE ANALYSIS, THE .064 SHEET IS REDUCED TO AN EQUIVALENT THICKNESS OF STEEL BY THE RATIO OF E_{AL} TO E_{ST}.

$E_{AL} = 10.5 \times 10^6$ PSI

$$t_{EQ} = .064 \times \frac{10.5}{29} = .023''$$

MEMBER	t	t + t_{EQ}	b	A*	L
CF	.051	.074	1.65	.12210	8.25
BC	.051	.074	1.55	.11470	4.80
BF	.180	.203	.52	.10556	9.545
EF	.051	.074	1.55	.11470	4.80
DE	.051	.074	1.55	.11470	4.80
AB	.051	.074	1.55	.11470	4.80
BE	.051	.074	1.32	.09768	8.25
AD	.051	.074	1.65	.12210	8.25
AE	.180	.203	.52	.10556	9.545

*NOTE: DEFLECTION RECALCULATED USING AREAS SHOWN ON SHT 2.7 (2/2/56)

TRUSS DEFLECTIONS (CONT)

TRUSS MEMBER	P_o DUE TO: W_c	OTHER LOADS	$\frac{\partial P_o}{\partial W_c}$
CF	$-W_c$	0	-1
BC	0	-3840	0
BF	$\frac{W_c\sqrt{(8.25)^2+(4.8)^2}}{8.25}$	$\frac{72882}{\sqrt{(8.25)^2+(4.8)^2}}$	$\frac{\sqrt{(8.25)^2+(4.8)^2}}{8.25}$
EF	$\frac{-4.8\,W_c}{8.25}$	0	$\frac{-4.8}{8.25}$
DE	$\frac{-9.6\,W_c}{8.25}$	3840	$\frac{-9.6}{8.25}$
AB	$\frac{4.8\,W_c}{8.25}$	-7680	$\frac{4.8}{8.25}$
BE	$-W_c$	-6600	-1
AD	$-W_c$	0	-1
AE	$\frac{W_c\sqrt{(8.25)^2+(4.8)^2}}{8.25}$	$\frac{72882}{\sqrt{(8.25)^2+(4.8)^2}}$	$\frac{\sqrt{(8.25)^2+(4.8)^2}}{8.25}$

THE SOLUTION FOR ΔC IS GIVEN IN TABULAR FORM ON SHT. 2.4
THIS GIVES A VALUE FOR ΔC OF;

$$\Delta C = .1471''$$

THE DEFLECTION OF THE STRUCTURE ABOVE & BELOW THE TRUSS IS DETERMINED FROM

$$\Delta = \frac{\sigma_s L}{G}$$

WHERE;

$$\sigma_s = \frac{q}{t} = \frac{1600}{.064} = 25000 \text{ PSI}$$

L = HORIZONTAL DISTANCE BETWEEN POINTS Ⓒ & Ⓓ = 9.6"
G = SHEAR MODULUS OF ELASTICITY = 2.5×10^6 PSI*

$$\therefore \Delta = \frac{2.5 \times 10^4 \times 9.6}{2.5 \times 10^6} = .096''$$

* A REDUCED MODULUS IS USED, ASSUMING THE SHEET TO BE BUCKLED.

A

BAR	1 1 L (IN)	2 2 A (IN²)	3–4 3 P_o W_c	5–6 4 P_o OTHER LOADS	7 5 $\frac{\partial P_o}{\partial W_c}$	8–9 6 ③ × ⑤ W_c	P_o $\frac{\partial P_o}{\partial W}$ OT…
CF	8.25	.1708	$-W_c$	0	-1	$\frac{+68.0625\,W_c}{68.0625}$	
BC	4.80	.1150	0	-3840	0	0	
BF	$\sqrt{(8.25)^2+(4.8)^2}$	.1214	$\frac{W_c\sqrt{(8.25)^2+(4.8)^2}}{8.25}$	$\frac{7288.2}{-\sqrt{(8.25)^2+(4.8)^2}}$	$\frac{\sqrt{(8.25)^2+(4.8)^2}}{8.25}$	$\frac{91.1025\,W_c}{68.0625}$	
EF	4.80	.1150	$\frac{-4.8\,W_c}{8.25}$	0	$\frac{-4.8}{8.25}$	$\frac{+23.04\,W_c}{68.0625}$	
DE	4.80	.1150	$\frac{-9.6\,W_c}{8.25}$	3840	$\frac{-9.6}{8.25}$	$\frac{92.16\,W_c}{68.0625}$	
AB	4.80	.1150	$\frac{4.8\,W_c}{8.25}$	-7680	$\frac{4.8}{8.25}$	$\frac{23.04\,W_c}{68.0625}$	
BE	8.25	.1642	$-W_c$	-6600	-1	$\frac{68.0625\,W_c}{68.0625}$	
AD	8.25	.1708	$-W_c$	0	-1	$\frac{68.0625}{68.0625}$	
AE	$\sqrt{(8.25)^2+(4.8)^2}$	.1214	$\frac{W_c\sqrt{(8.25)^2+(4.8)^2}}{8.25}$	$\frac{7288.2}{\sqrt{(8.25)^2+(4.8)^2}}$	$\frac{\sqrt{(8.25)^2+(4.8)^2}}{8.25}$	$\frac{91.1025\,W_c}{68.0625}$	
Σ							

$$\Delta c = \frac{1}{29\times10^6}\left[\frac{30090.6\,W_c}{68.0625} + \frac{11{,}118{,}856}{8.25}\right] = \frac{1}{29\times10^6}\left[2.91\ldots\times10^6 \ldots\right.$$

FORM 1543

A. V. ROE CANADA LIMITED
MALTON, ONTARIO
TECHNICAL DEPT. (AIRFRAME)

AIRCRAFT - - C105
WEIGHT - -
C. G. POSITION -

REPORT NO. - 7/0558/67
SHEET - - 24
DATE - - 1/31/56
PREPARED BY - E. KAUTT

7	8–9	10–11	12	13–14	15–16	17	18	19
5	6	7	8					
	P_o	$\frac{\partial P_o}{\partial W_c}$	L/A	$\frac{P_o L}{A}$	$\frac{\partial P_o}{\partial W_c}$			
$\frac{\partial P_o}{\partial W_c}$	$\frac{③ \times ⑤}{W_c}$	④ × ⑤ OTHER LOADS	$\frac{①}{②}$	$\frac{68.0625 \times ⑥ \times ⑧}{W_c}$	8.25 × ⑦ × ⑧ OTHER LOADS			
−1	$\frac{+68.0625 W_c}{68.0625}$	0	48.302	3287.6 W_c	0			
0	0	0	41.739	0	0			
$\frac{(8.25)^2+(4.8)^2}{8.25}$	$\frac{91.1025 W_c}{68.0625}$	$\frac{72.882}{8.25}$	78.623	7162.8 W_c	5,730,201			
$\frac{-4.8}{8.25}$	$\frac{+23.04 W_c}{68.0625}$	0	41.739	961.7 W_c	0			
$\frac{-9.6}{8.25}$	$\frac{92.16 W_c}{68.0625}$	$\frac{-36.864}{8.25}$	41.739	3846.7 W_c	−1,538,666			
$\frac{4.8}{8.25}$	$\frac{23.04 W_c}{68.0625}$	$\frac{-36.864}{8.25}$	41.739	961.7 W_c	−1,538,666			
−1	$\frac{68.0625 W_c}{68.0625}$	$\frac{54.450}{8.25}$	50.244	3419.7 W_c	2,735,786			
−1	$\frac{68.0625 W_c}{68.0625}$	0	48.302	3287.6 W_c	0			
$\frac{(8.25)^2+(4.8)^2}{8.25}$	$\frac{91.1025 W_c}{68.0625}$	$\frac{72.882}{8.25}$	78.623	7162.8 W_c	5,730,201			
				30090.6 W_c	11,118,856			

$$\ldots 6\,\Big] = \frac{1}{29 \times 10^6}\left[2.91[illegible] \times 10^6 + 1.34774 \times 10^6\right] = \frac{4.26562}{29} = .14709''$$

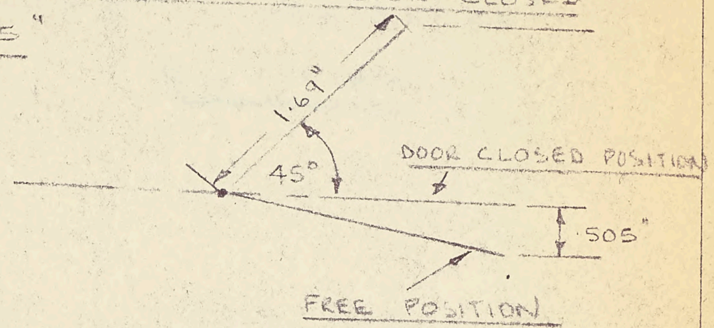
AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT:		REPORT No. 7/0558/67	
		SHEET No. 7.2	
C.105	FLAT SPRINGS	PREPARED BY: A.J. QUIGLEY	DATE: MAY 1956
		CHECKED BY	DATE

REF DRG 7-1058-6415

SPRING BENT AT 45° TO NORMAL CLOSED POSITION

DEFLECTION FROM FREE POSITION TO DOOR-CLOSED POSITION IS ·505"



DEFLECTION AT 45° POSITION = ·505 + 1·69 Sin 45

= ·505 + 1·69 × ·7071

$$\delta = 1 \cdot 7''$$

$$\delta = \frac{WL^3}{3EI} \quad ; \quad W = \frac{3EI\delta}{L^3}$$

$$= \frac{3 \times 30 \times 10^6 \times 1 \cdot 7 \times \cdot 9 \times \cdot 015^3}{12 \times 1 \cdot 69^3}$$

$$W = 8 \cdot 0 \text{ LB}$$

BENDING STRESS $= \frac{My}{I} = \frac{8 \times 1 \cdot 69 \times \cdot 0075}{\cdot 253 \times 10^{-6}}$

$= 402,000 \text{ LB/IN}^2$

THE HIGH STRESS QUOTED ABOVE IS CONSIDERED ACCEPTABLE BECAUSE OF THE DEFORMATIONS WHICH THE LOADING WILL IMPOSE ON THE SPRING.

FORM 1319A

AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT:		REPORT NO. 7/0558/67	
		SHEET NO. 7.3	
C.105	SPRING - COILED	PREPARED BY	DATE
	DRG 7-1058-6413	A.J.QUIGLEY	MAY 1955.
		CHECKED BY	DATE

MEAN DIA OF SPRING = ·149"   FREE LENGTH ·9"

DIA OF WIRE ·026"   12 COILS

$$\text{SPRING RATE } x = \frac{Gd^4}{64NR^3} = \frac{11\times10^6 \times \cdot026^4}{64\times12\times\cdot149^3}$$

$$x = 1{\cdot}98 \text{ LB/IN}$$

FORM 1319 A

AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT: C 105	AIR VENTS	REPORT No. 7/0558/67 SHEET No 8.0
		PREPARED BY: KAUTT — DATE: 5/25/56
		CHECKED BY: — DATE:

SECTION 8

STRESSING

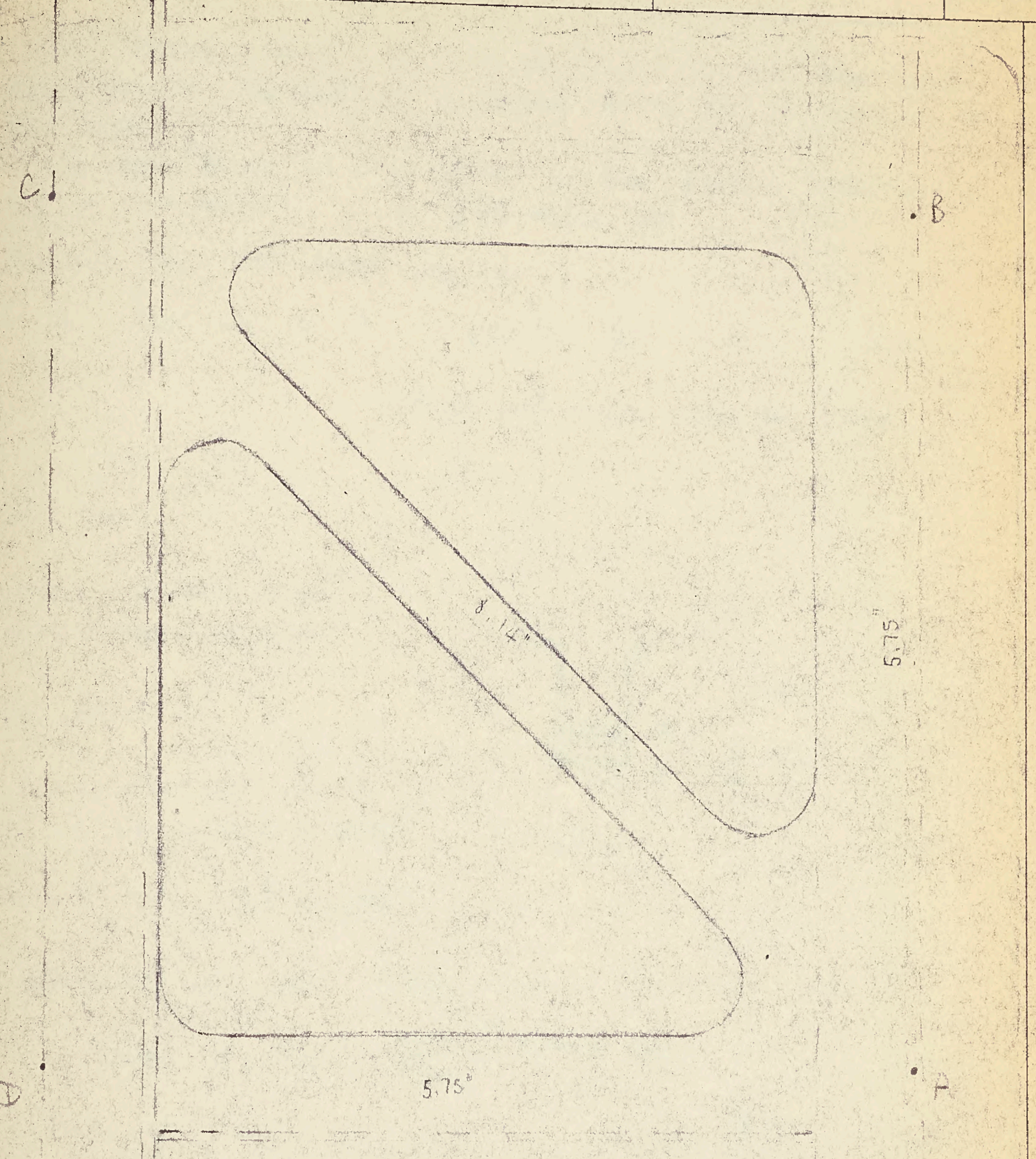
VENT BETWEEN STN 702.30 & STN 707.32

DWG 7-1058-4707/08

FORM 1319 A

AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

REPORT No. 71/0558/67		
SHEET No. 8.1		
AIRCRAFT: C.105	VENT STA. 702.30 -707.32	
PREPARED BY	DATE	
[illegible]	Feb 56	
CHECKED BY	DATE	



FORM 1319A

THE APPLIED SHEAR IS 1600 LBS/INCH IN THE 10G CASE. THE DIAGONAL MEMBER IS SO PLACED AS TO BE IN TENSION IN THIS CASE.

THE MAX. VALUE OF THE SHEAR IN THE REVERSE DIRECTION IS 41% OF 1600 LBS/INCH, I.E. 656 LB/IN ULT.

CONSIDER THE MAX. SHEAR CASE FIRST:

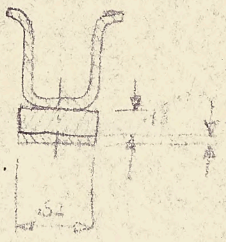
THE MAX. LOAD AT 'A' IN DIRECTION BA = 5.75 × 1600 = 9200 LBS (ULT)

TENSILE LOAD IN CA = 13000 LBS (ULT.)

GROSS AREAS:

STEEL = .18 × .52 = .0936 □"

ALUM. = .064 × .52 = .0333 □"



NET AREAS:

STEEL = .0936 − .1285 × .18

= .0936 − .0231 = .0705 □"

ALUM = .0333 − .009 = .024 □"

EQUIVALENT NET STEEL AREA = $.0705 + \frac{10.5}{29.0} \times .024 = .0792$ □"

STRESS IN STEEL = $\frac{13000}{.0792} = 164000$ LB/□"

$M.S. = \frac{180000}{164000} - 1 = .10$

AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT:		REPORT NO. 7/0558/67	
C.105	VENT STA. 722.30 - 707.32	SHEET NO. 8.3	
		PREPARED BY	DATE
		[illegible]	FEB. '56
		CHECKED BY	DATE

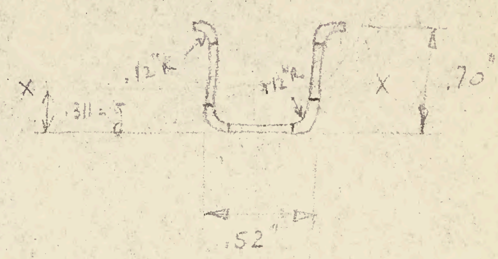
CHANNEL

AREA = .0736 □"

$$\bar{y} = \frac{.0176 \times .7 + .0304 \times .35}{.0736}$$

$$= \frac{.02296}{.0736}$$

$$= .311"$$



$$I_{xx} = .0080 \times (.291)^2 + .0176 \times (.231)^2 + .0176 \times (.289)^2 + 2 \times \frac{1}{12} \times .040 \times (.35)^3$$

$$= 6.776 \times 10^{-4} + 9.38 \times 10^{-4} + 14.70 \times 10^{-4} + 3.65 \times 10^{-4}$$

$$= 34.51 \times 10^{-4} \text{ in}^4$$

TO CALCULATE THE ALLOWABLE COMPRESSIVE LOAD ON 'CA':

LENGTH BETWEEN [illegible] = 6.0"

[REF: TIMOSHENKO THEORY OF ELASTIC STABILITY page 108]

DEFLECTION AT CENTRE ASSUMING 'CA' UNIFORMLY LOADED:

$$\frac{W}{\delta} = \frac{384EI}{5L^3} = \frac{384 \times 10^7 \times 34.51 \times 10^{-4}}{5 \times 36 \times 6} = 12290 \text{ LB/IN}$$

$$\beta = \frac{12290}{3} = 4097 \text{ LB/in}^2$$

$$\frac{\beta \ell^4}{16EI} = \frac{4097 \times 36 \times 36}{16 \times 10 \times 10^6 \times .000347} = 33.0$$

$$L/\ell = .432 \qquad L = 2.59"$$

AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT:		REPORT No. 7/0558/67	
C. 105	VENT. STA. 702.30 – 707.32	SHEET No. 8.4	
		PREPARED BY	DATE
		[illegible]	FEB. 58
		CHECKED BY	DATE

ALLOWABLE END LOAD $P_u = \dfrac{\pi^2 \times 29 \times 10^6 \times 347 \times 10^{-6}}{6.71} = 14800$ LBS

THIS IS WELL IN EXCESS OF THE APPLIED LOAD OF 5330 LBS

M.S. = 1.78

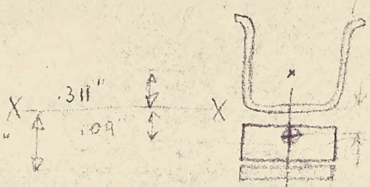
FORM 1319A

AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT:		REPORT No. 7/0558/67	
C.105	VENT STA. 702.30 – 707.32	SHEET No. 8.5	
		PREPARED BY	DATE
		[signature]	FEB. 56
		CHECKED BY	DATE

EFFECT OF OFFSET DUE TO CURVATURE:

.040" THICK



$A_1 = .0736$ □"

$A_2 = .2585$ □" (EQUIV. ALUM.)

$A_3 = .0333$

$$\bar{y} = \frac{.0736 \times .311 - .2585 \times .09 - .0333 \times .21}{.3654}$$

$$= \frac{.0229 - .02325 - .00699}{.3654} = -.020'' \text{ FROM X X}$$

$$I = .003416 + .0736 \times (.331)^2 + .000347 + .2918 \times (.08)^2$$

$$= .003416 + .00809 + .000347 + .00187 = .01372''^4$$

(ABOUT CENTROID)

DUE TO CURVATURE, A MOMENT RESULTS FROM THE APPLICATION OF END LOAD.

OFFSET = .10"

END LOAD = 13000 LB (ULT) TENSION)

LENGTH = 6.0"

THE MAX B.M. IS APPROXIMATELY GIVEN AS FOLLOWS. (REF: ROARK, PAGE 133)

$$M' = \frac{13000 \times .1}{1 + \alpha \frac{Pl^2}{EI}}$$

$$\frac{Pl^2}{EI} = \frac{13000 \times 36}{10^7 \times .01372} = 3.41$$

$\alpha = \frac{1}{2}$ (PIN ENDED – EQUAL & OPPOSITE END COUPLES)

FORM 1319A

AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

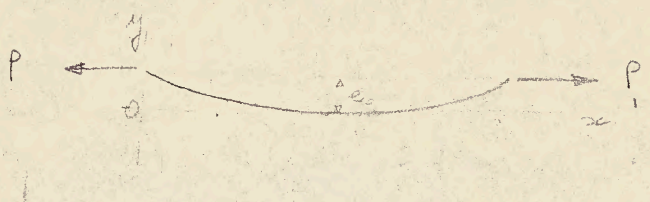
AIRCRAFT:		REPORT No. 7/0558/67
C.105	VENT STA. 702.30 – 707.52	SHEET No. 8.6

PREPARED BY	DATE
[illegible]	FEB. 56
CHECKED BY	DATE

$$M' = \frac{1300}{1+1.7} \quad 482 \text{ LB-IN (ULT.)}$$

MAKING A MORE EXACT ANALYSIS:

CONSIDER A STRUT WITH AN INITIAL BOW UNDER TENSION, AS SHOWN:



THE INITIAL CURVATURE IS GIVEN AS $e = e_0 \sin \frac{\pi x}{l}$

THE MOMENT AT ANY POINT IS $M = P(e - y)$

DIFFERETIATING TWICE $\ddot{M} = P(\ddot{e} - \ddot{y})$

NOW $\ddot{e} = e_0 \left(\frac{\pi}{l}\right)^2 \sin \frac{\pi x}{l}$

$\ddot{y} = -\frac{1}{EI} M$

LET $\mu^2 = \frac{P}{EI}$

THE MOMENT CAN THEREFORE BE EXPRESSED BY THE FOLLOWING DIFFERENTIAL EQUATION

$$\ddot{M} - \mu^2 M = -Pe_0 \left(\frac{\pi}{l}\right)^2 \sin \frac{\pi x}{l}$$

WHOSE SOLUTION IS

$$M = A \sinh \mu x + B \cosh \mu x + Pe_0 \left[\frac{P_E}{P_E + P}\right] \sin \frac{\pi x}{l}$$

WHERE $P_E = \frac{\pi^2 EI}{l^2}$

FORM 1319A

AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT:		REPORT No. 7/0558/67
C.105	VENT STA 702.30 - 707.32	SHEET No. 8.7
		PREPARED BY: [signature] DATE: FEB. 56
		CHECKED BY: DATE:

THE FIRST TWO TERMS OF THIS EQUATION ARE THE SOLUTION OF THE DIFFERENTIAL EQUATION WITH THE RIGHT HAND SIDE SET EQUAL TO ZERO. THIS, THEREFORE, REPRESENTS A SELF-EQUILIBRATING SYSTEM OF STRESSES WHICH IS NON-EXISTANT IN THIS INSTANCE. HENCE, THE CONSTANTS 'A' & 'B' MUST BE ZERO.

$$\therefore \quad M = Pe_0 \left[\frac{P_E}{P_E + P} \right]$$

TAKING $P_E = 14800$ LBS

$$M = 1300 \left[\frac{14800}{27800} \right] = 691 \text{ LB-IN}$$

MAX TENSILE STRESS AT FREE EDGE OF CHANNEL $= \frac{691 \times .72}{.01372} = 36300$ LB/IN² O.K.

FORM 1319A

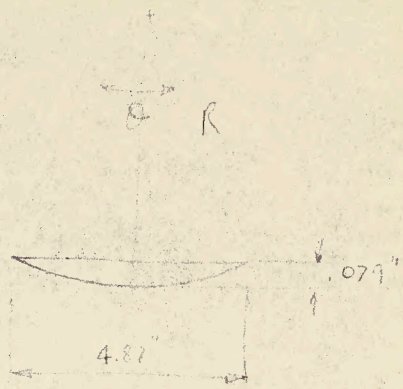
AVRO AIRCRAFT LIMITED MALTON - ONTARIO TECHNICAL DEPARTMENT		REPORT No. 7/0558/67 SHEET No. 8.8	
AIRCRAFT: C.105	VENT. STA. 702.30 - 707.32	PREPARED BY [illegible]	DATE FEB. 1-56
		CHECKED BY	DATE

LOCAL CURVATURE:

$(R - .079)^2 + (2.435)^2 = R^2$

$R^2 - .158R + .00624 + 5.9292 = R^2$

$R = 37.57''$



REFERRING TO REPORT ON "CUT-OUTS FOR ONE WAY AIR COOLING VALVES, #3 & #4 VENTS" SECTION 3

THE INCLUDED ANGLE θ IS 8° BETWEEN POINTS 'A' & 'B'.

∴ MOMENT DUE TO CURVATURE BETWEEN POINTS 'A' & 'B' IS

$M = qR^2 \left[\theta - \sin\theta \right]_0^{8°}$

$= 1600 \times (37.57)^2 \left[.13963 - .13917 \right]$

$= 1600 \times 1411.5 \times .00046$

$M = 1039$ LB. IN

IN ACCORDANCE WITH CALCULATIONS MADE BY MR. [illegible], THIS MOMENT CAN BE REACTED BY THE FRAMES WITHOUT ANY REINFORCING.

ORM 1319A

AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT:		REPORT NO. 7/0558/67
C.105	VENT AT STA. 702.30 – 707.32	SHEET NO. 8.9
		PREPARED BY: [signature] DATE: FEB. 1956
		CHECKED BY: DATE:

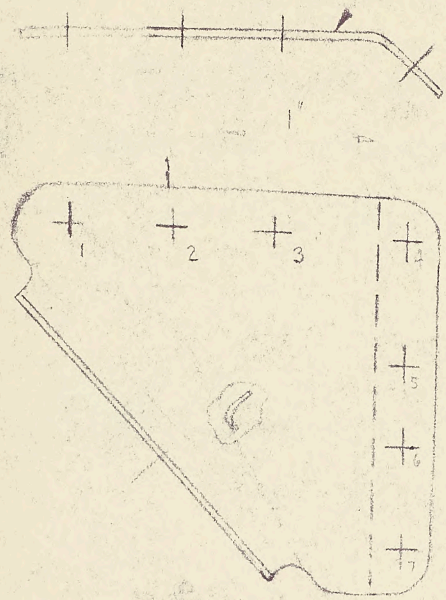
CLEATS ON DIAGONAL MEMBER A-C.

DRWGS: 7-1058-4723/4724 AND 7-1058-4725/4726.

TENSILE LOAD IN CA = 13000 LBS (ULT.)

LOAD IN CLEATS = 13000 $\sin 4^\circ$ = 13000 × .06976 = 907 LBS (ULT.)

.040" THICK 75S



LOAD PER CLEAT = 453.5# (ULT.)

MOMENT ON RIVETS 1, 2 & 3: M = 453.5 × 1.30 = 589 #-"

FORCE ON RIVET 3) MAX. = $\frac{453.5}{3} + \frac{589}{1.30}$ = 151.2 + 453.5

= 604.7#

FORM 1319A

AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT:		REPORT No. 7/0558/67	
C.105	VENT. AT STATION 702.30 - 707.32	SHEET No. 8.10	
		PREPARED BY	DATE
		[signature]	FEB. 58
		CHECKED BY	DATE

1/8 DIA. BLIND MONEL CHERRY RIVET TYPE CR.563 IN .040" 75S MATERIAL.

ALLOWABLE SHEAR = 620 LBS (ANC-5)

ALLOWABLE BEARING = .93 × 1.37 × 514 = 655 LBS (ULT.) (AT 265°F - 333 HRS)

$$M.S. = \frac{620}{604.7} - 1 = .03$$

RIVETS 4 TO 7 ON ALL CLEATS ARE OF MORE THAN ADEQUATE STRENGTH. 1/8" PROTRUDING HD AL. ALLOY RIVETS ARE ADEQUATE.

FORM 1319A

AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT:		REPORT No. 7/0558/67	
		SHEET No. 5.0	
		PREPARED BY	DATE
C 105	AIR VENTS	KAUTT	5/25/56
		CHECKED BY	DATE

SECTION 5

STRESSING

FRAME WEB STIFFENERS

SEE DRG: 7-1058-57/8.

FORM 1319A

AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT:		REPORT NO. 7/0558/67	
C-105	VENTS #1 & #2	SHEET NO. 5.1	
		PREPARED BY	DATE
		[signature]	FEB. 1958
		CHECKED BY	DATE

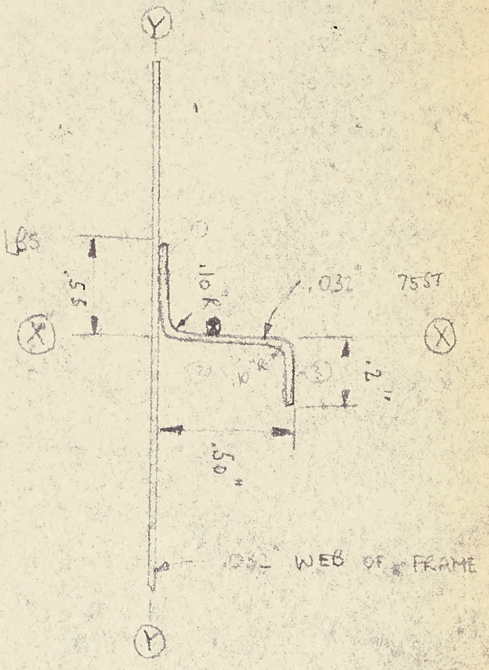
FRAME WEB STIFFENERS: IN THE REGION OF THE VENT DUCTS, THESE STIFFENERS HAVE TO PERFORM AN ADDITIONAL FUNCTION, NAMELY REACT PRESSURES IN THE DUCT.

PRESS. IN DUCT = 16.65 LBS/□" (ULT)

PITCH OF STIFFENERS = 2.7"
DEPTH OF FRAME = 3.0"
AREA OF PANEL = 8.1 □"
FORCE ON PANEL = 8.1 × 16.65 = 134.9 LBS
PERIPHERY = 11.4"

$$\text{LOAD/INCH} = \frac{134.9}{11.4} = 11.82 \text{ LB/IN}$$

$$\text{MAX. B.M.} = \frac{11.82 \times 9}{8} = 13.3 \text{ LB-IN}$$



TAKING 1" EFFECTIVE WEB AS ACTING WITH STIFFENER:

		$\bar{x}$	$A\bar{x}$
SKIN	1 × .032 = .032 □"	0	0
(1)	= .0176 □"	0	0
(2)	= .016 □"	.25"	.004
(3)	= .0064 □"	.50"	.0032
	ΣA = .0720 □"		Σ .0072

$$\bar{x} = \frac{.0072}{.072} = .10"$$

MOMENT OF INERTIA ABOUT CENTROID:

$$I = .032 \times (.10)^2 + (.0176) \times (.10)^2 + .016 \times (.15)^2 + .0064 \times (.40)^2 + \frac{1}{12} \times .032 \times (.50)^3$$

$$= .000496 + .000360 + .001022 + .000333$$

$$= .00221''^4$$

FORM 1319A

AVRO AIRCRAFT LIMITED
MALTON · ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT:		REPORT No. 7/0558/67	
C. 105	VENTS #1 & #2 #3 & #4	SHEET No. S.2	
		PREPARED BY [signature]	DATE FEB. 1956
		CHECKED BY	DATE

$$\text{MAX. STRESS} = \frac{13.3 \times .40}{.00221} = 2410 \text{ Lb}/\text{in}^2$$

THIS STRESS IS ADDITIVE TO ANY OTHERS THAT MIGHT NORMALLY BE IMPOSED ON THE WEB STIFFENER.

FORM 1319A

AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT:		REPORT No. 7/0558/67	
C 105	AIR VENTS	SHEET No. 6.0	
		PREPARED BY	DATE
		KAUTT	5/25/56
		CHECKED BY	DATE

SECTION 6

STRESSING

VENTS 5, 6, 7, & 8

DWG 7-1058-5755
DWG 7-1058-6217

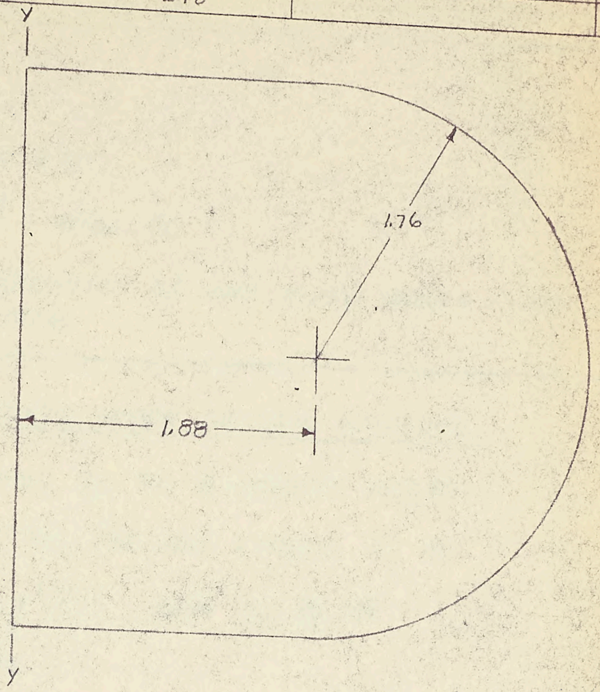
FORM 1319A

AVRO AIRCRAFT LIMITED
MALTON · ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT:		REPORT No. 7/0558/67	
C 105	ONE-WAY COOLING AIR VENTS DWG 7-0158-290	SHEET No. 6.1	
		PREPARED BY KAUTT	DATE 2/7/56
		CHECKED BY	DATE

BOTTOM DOORS
(VENTS 7 & 8)

THE VENT DOORS ARE CONSIDERED TO BE OF THE DIMENSIONS SHOWN. AXIS Y-Y REPRESENTS THE HINGE LINE. NORMAL PRESSURE ON THE DOOR IS 24.85 PSIU



$A = (2)(1.76)(1.88) + (.5)(1.76)^2\pi$
$= 11.5''^2$

TOTAL LOAD $W = PA$

$W = 24.85 \times 11.5 = 286^{\#}$

THE TOTAL LOAD, W, IS CONSIDERED TO BE UNIFORMLY DISTRIBUTED AROUND THE PERIMETER, S.

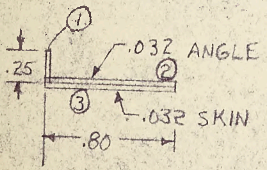
$$S = (2)(1.88) + 1.76\pi + (2)(1.76) = 12.8''$$

$$w = \frac{W}{S} = \frac{286}{12.8} = 22.3\ \#/''$$

THE STRUCTURE ALONG THE HINGE LINE IS CONSIDERED TO CARRY THE UNIFORM LOAD w AS BENDING OF A SIMPLY SUPPORTED BEAM.

$$M_{MAX} = \frac{wL^2}{8} = \frac{(22.3)(3.52)^2}{8} = 34.6\ ''\#$$

THE STRUCTURE ALONG THE HINGE LINE CONSISTS OF .032 75S-T6 SKIN* PLUS AN .032 75S-T6 LIPPED ANGLE SHOWN BELOW.



ITEM	b	A	y	Ay	Ay²	I_o
1	.22	.00704	.174	.001225	.000213	.000028
2	.77	.02464	.048	.001183	.000057	.000002
3	.80	.02560	.016	.000410	.000007	.000002
Σ	—	.05728	—	.002818	.000277	.000032

$\bar{y} = \frac{.002818}{.05728} = .0492''$

$I = .000309 - .000139 = .00017''^4$

* NOTE: INCREASE SKIN TO .051 TO TAKE CARE OF PLATE STRESSES

AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT: C 105	ONE-WAY COOLING AIR VENT DWG 7-0158-290	REPORT NO. 7/0558/67 SHEET NO. 6.2
		PREPARED BY: KAUTT — DATE: 2/7/56
		CHECKED BY: — DATE:

BOTTOM DOORS (CONT)

$$c = .25 + .032 - .049 = .233''$$

$$f = \frac{Mc}{I} = \frac{34.6 \times .233}{.00017} = 47400 \text{ PSI}$$

THIS ANALYSIS IS CONSERVATIVE AS THE HINGE SHOULD CARRY LESS LOAD THAN WAS ASSUMED.

CHECK OF DOOR AS A PLATE UNDER UNIFORM PRESSURE

THE DOOR IS CONSIDERED TO BE A SQUARE PLATE.

FROM ROARK, 2nd EDITION, THE MAX STRESS, S, IS:

$$S = .2208\, w a^2 (1+\nu^2)/t^2 \quad \text{CASE 30, Pg 196}$$

WHERE: $w = 24.85$ PSIU
$a = 3.52''$
$\nu = .3$
$t = .051$

$$S = \frac{(.2208)(24.85)(3.52)^2(1.3)}{(.051)^2} = 34000 \text{ PSI}$$

PLATE IS OK

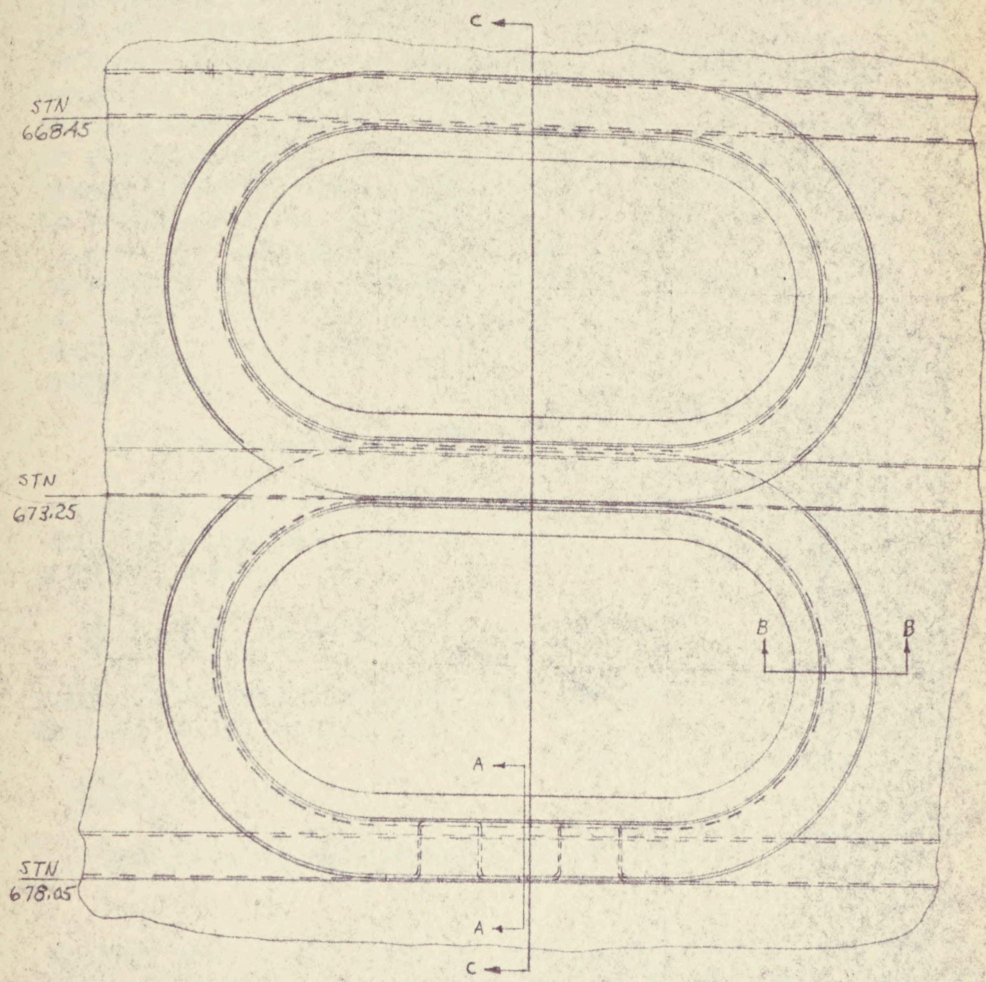
F_{ty} = 35,000 PSI

FORM 1319A

AVRO AIRCRAFT LIMITED
MALTON · ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT: C 105.	ONE-WAY COOLING AIR VENTS DWG 7-0158-290	REPORT NO. 7/0558/67	
		SHEET NO. 6.3	
		PREPARED BY	DATE
		KAUTT	2/13/56
		CHECKED BY	DATE

VENTS 7 & 8



FORM 1319A

AVRO AIRCRAFT LIMITED
MALTON ONTARIO
TECHNICAL DEPARTMENT

REPORT No. 7/0558/67
SHEET No. 6.4

AIRCRAFT:		PREPARED BY	DATE
C 105	ONE-WAY COOLING AIR VENTS DWG 7-0158-290	KAUTT	2/13/56
		CHECKED BY	DATE

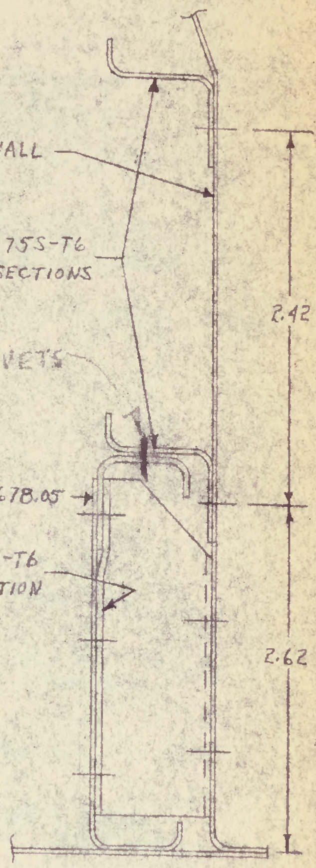
VENTS 7 & 8 (CONT)

THE DUCT IS SUPPORTED BY TWO .032" 75S-T6 ZEE SECTIONS WHICH ACT AS FRAMES TO REACT THE INTERNAL PRESSURE LOADING IN THE DUCT. IT IS ASSUMED THAT THE UPPER FRAME SUPPORTS 2.42/2 = 1.21" OF PRESSURE LOAD, THE LOWER FRAME SUPPORTS (2.42 + 2.62)/2 = 2.52" OF PRESSURE LOAD, & THAT 2.62/2 = 1.31" OF PRESSURE LOAD ARE SUPPORTED BY THE FUSELAGE SKIN & DUCT LIP. SINCE THE PRESSURE IS 24.85 PSIU, THE LOADING ON THE LOWER FRAME IS:

$$w = 2.52 \times 24.85 = 62.6 \ \#/'' \text{ ULT.}$$

ASSUMING THE FRAMES TO BE ELLIPTICAL SHAPED WITH $a = 3.5''$ & $b = 2.0''$, THEN;

$$\frac{b}{a} = .57, \text{ \& FROM}$$



SECTION A-A

R.A.S. DATA SHEET 03.06.05, THE MAXIMUM MOMENT IS AT SECTION B-B, &

$$\frac{M}{wa^2} = .2, \quad \text{OR}$$

$$M = .2wa^2 = (.2)(62.6)(3.5)^2 = 153 \ ''\#$$

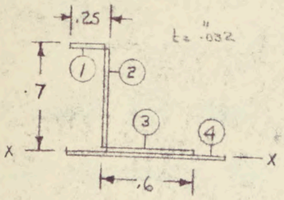
SECTION B-B IS THE SAME AS SECTION, IN SO FAR AS THE ZEE SECTIONS ARE CONCERNED. IT IS ASSUMED THAT 1" OF THE DUCT WALL ACTS WITH THE "Z" TO RESIST BENDING & AXIAL LOAD.

FORM 1319A

AVRO AIRCRAFT LIMITED
MALTON · ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT:		REPORT No. 7/0558/67	
		SHEET No. 6.5	
C 105	ONE-WAY COOLING AIR VENTS DWG 7-0158-290	PREPARED BY	DATE
		KAUTT	2/14/56
		CHECKED BY	DATE

VENTS 7 & 8 (CONT)



ITEM	A	Y	AY	AY²	Io
1	.0070	.684	.00479	.00327	—
2	.0205	.350	.00718	.00251	.00070
3	.0182	.016	.00029	—	—
4	.0320	-.016	-.00051	.00001	—
	.0777	—	.01175	.00579	.00070

$\bar{y} = \frac{.01175}{.0777} = .151''$

$I = .00649 - .00178 = .00471 \text{ in}^4$

AXIAL LOAD AT SECTION B-B (HOOP TENSION)

$T = \frac{wL}{2} = \frac{62.6 \times 7.73}{2} = 242^{\#}$

$f_c = \frac{(.7 - .151)(153)}{.00471} - \frac{242}{.0777} = 17840 - 3120 = 14720 \text{ PSI}$

$F_{cc} = 37000 \text{ PSI}$

MS > 1

$f_t = \frac{(.151 + .016)(153)}{.00471} + \frac{242}{.0777} = 5420 + 3120 = 8540 \text{ PSI}$

MS = HIGH

FORM 1319A

AVRO AIRCRAFT LIMITED
MALTON · ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT: C 105	ONE-WAY COOLING AIR VENTS DWG 7-0158-290	REPORT NO. 7/0558/67	SHEET NO. 6.6
		PREPARED BY: KAUTT	DATE: 2/9/56
		CHECKED BY:	DATE:

VENTS 7 & 8

THE INTERNAL DUCT PRESSURE IS 24.85 PSIU. IT IS ASSUMED THAT THE PRESSURE LOADING IS RESISTED BY THE ZEE SECTIONS PROVIDED FOR THAT PURPOSE

HOOP TENSION = PR = 24.85 × 2 = 45.7 #/"

DUCT IS .032 75S-T6 SHT $f_t = \frac{45.7}{.032} = 1430$ PSIU

MS = HIGH

LOAD ON HAT SECTIONS

W = 3.75 P = 3.75 × 24.85 = 93.2 #/"

W IS RESISTED BY THE FOUR LEGS OF THE TWO HAT SECTIONS AS COLUMNS. LOAD PER LEG = 93.2/4 = 23.3#

CONSIDER LEGS AS PIN-ENDED COLUMNS WITH L = .7"

$t = .04 \qquad \rho = \frac{t}{\sqrt{12}} = .0115 \qquad L/\rho = \frac{.7}{.0115} = 61$

FROM FIG. 6.1.3-3 AVRO E.M. $f_c = 26{,}000$ PSI

$f = \frac{23.3}{.04} = 575$ PSI

MS = HIGH

TOTAL LOAD ON DOORS

$A = (3.75)(4) + \pi(2)^2 = 27.6 \text{ "}^2$

$W = PA = 24.85 \times 27.6 = 685$#

ASSUMING THAT W IS REACTED BY 4 AD4 RIVETS AT EACH SIDE OF DUCT, LOAD/RIV = (.125)(685) = 86 #

SHEAR VALUE = 388 × .964 = 374 #

MS = HIGH

FORM 1319A

AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT: C 105	ONE WAY COOLING AIR VENTS DWG 7-0158-290	REPORT NO. 7/0558/67	SHEET NO. 67
		PREPARED BY: KAUTT	DATE: 2/9/56
		CHECKED BY:	DATE:

VENTS 7 & 8 (CONT)

ASSUME THAT W IS RESISTED EQUALLY AROUND PERIMETER (S) OF DUCT.

$$S = (3.75)(2) + 2\pi(2) = 20.1''$$

$$w = \frac{W}{S} = \frac{685}{20.1} = 34.1\ \#/''$$

ASSUME THAT w IS TRANSFERRED TO SIDE RIVETS BY THE DUCT SIDEWALL BY BEAM ACTION. ASSUMED LENGTH IS 4"

$$M_{MAX} = \frac{wL^2}{8} = \frac{34.1 \times 16}{8} = 68.2\ ''\#$$

SIDE WALL IS 5" DEEP, $t = .032''$

$$f = \frac{6M}{t h^2} = \frac{6 \times 68.2}{.032 \times (5)^2} = 512\ PSI$$

HOOP TENSION IS 1430 PSI SO THERE IS NO RESULTANT COMPRESSION.

$$f_{t_{MAX}} = 512 + 1430 = 1942\ PSI\ U \qquad MS = HIGH$$

~~TOTAL SIDE LOAD = 93.2 #/" ASSUMING HALF GOES TO EACH HAT SECTION & IS REACTED BY FRAME CAPS, THE MAXIMUM SIDE LOAD ON A FRAME CAP (FROM EACH HAT) IS: (h = 5")~~

~~$$R = 93.2 \times \frac{1}{2} \times \frac{1}{2} \times 5 = 116.5\#$$~~

FORM 1319A

AVRO AIRCRAFT LIMITED
MALTON · ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT:		REPORT NO. 7/0558/67	
C 105	ONE-WAY COOLING AIR VENTS DWG 7-0158 290	SHEET NO. 6.8	
		PREPARED BY	DATE
		KAUTT	2/10/56
		CHECKED BY	DATE

VENTS 7 & 8 (CONT)

CHECK OF SIDE WALL. COMBINED TENSION & SHEAR.

CONSIDER, THE DEVELOPED LENGTH OF THE END PORTION OF THE DUCT AS A FLAT PANEL.

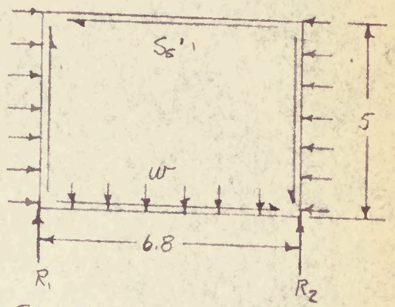
$R_1 = R_2 = .5 \times 6.8 \times w$

$3.4 \times 34.1 = 116^{\#}$

$\text{SHEAR STRESS} = \dfrac{R}{bt} = S_s$

$b = 5 \quad t = .032$

$S_s = \dfrac{116}{.032 \times 5} = \underline{\underline{725 \text{ PSI}}}$



FROM ROARK, 2nd ED, SHT 302, CASE E:

$$S_s' = \sqrt{C^2\left(2\sqrt{1-\frac{S_y}{C}} + 2 - \frac{S_x}{C}\right)\left(2\sqrt{1-\frac{S_y}{C}} + 6 - \frac{S_y}{C}\right)}$$

WHERE:

$$C = \frac{.823}{1-\nu^2}\left(\frac{t}{b}\right)E$$

$\nu = .3$

$E = 10.5 \times 10^6$ PSI

$t = .032''$

$b = 5''$

$C = 389$ PSI

$S_x = -1430$ PSI (HOOP TENSION)

$S_y = 0$

THEN:

$S_s' = 3049$ PSI

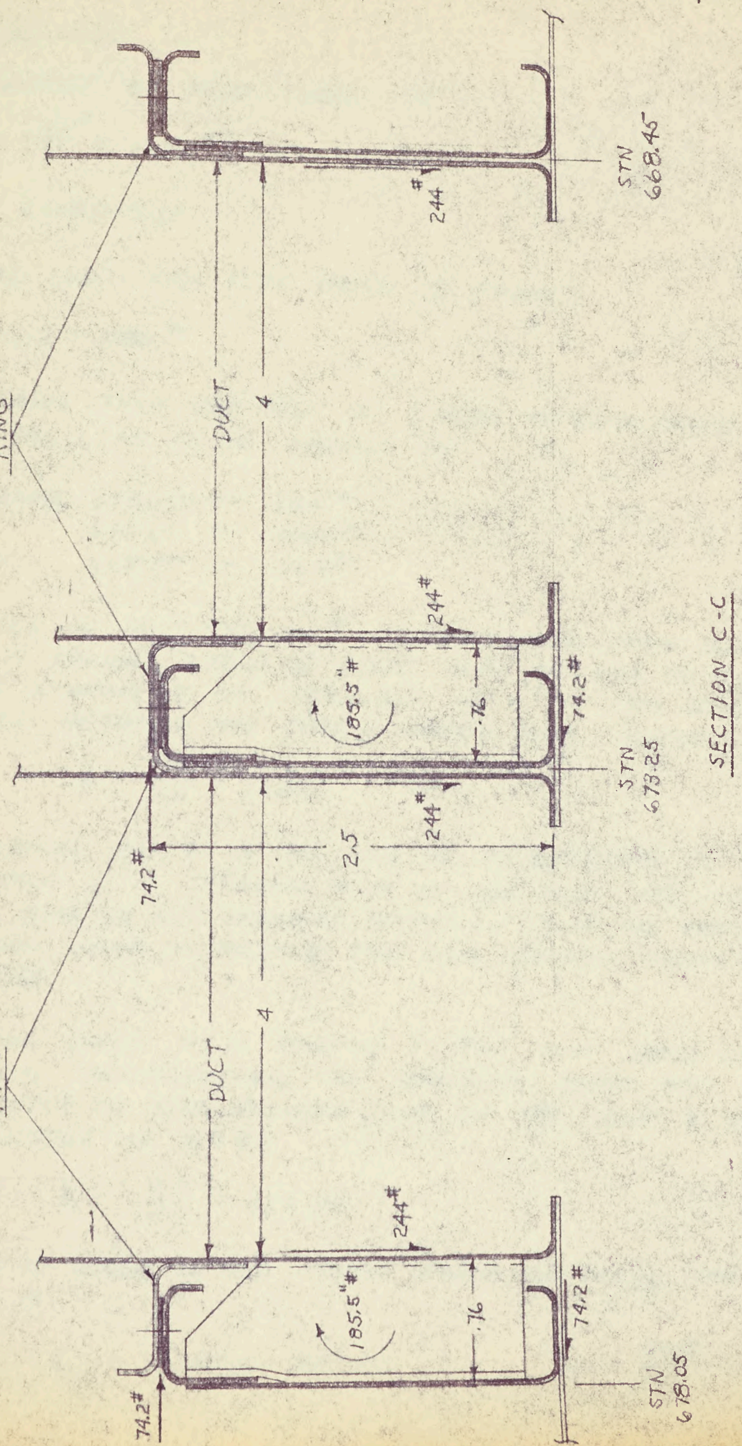
$MS = \dfrac{3049}{725} - 1 > 1$

FORM 1319 A

AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

REPORT No. 7/0558/67
SHEET No. 6.9

AIRCRAFT:		PREPARED BY	DATE
C 105	ONE-WAY COOLING AIR VENTS DWG 7-0158-270	KAUTT	2/16/56
		CHECKED BY	DATE



FORM 1319A

AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

REPORT No. 7/0558/67
SHEET No. 6.10

AIRCRAFT:		PREPARED BY	DATE
C 105	ONE-WAY COOLING AIR VENTS DWG 7-0158-290	KAUTT	2/16/56
		CHECKED BY	DATE

SECTION C-C

DIAMETER OF VENT TUBES = 5"

$A = \frac{\pi D^2}{4} = 19.65''^2$

$P = 24.85$ PSIU

TOTAL LOAD FROM TUBE GOING TO FRAMES

$W = PA = 488^{\#}$

ASSUMING THAT ONE-HALF OF W GOES TO EACH FRAME, THE VERTICAL LOAD ONTHE FRAMES IS:

FRAME	678.05 ~	244#
"	673.25 ~	488#
"	668.45 ~	244#

AS SEEN IN SECT. C-C, 244# IS TRANSFERRED FROM THE DUCT SIDE WALL TO FRAMES 678.04 & 673.25 THRU THE HAT SECTIONS. THIS CAUSES A MOMENT OF 244 x .76 = 185.5"#. THIS MOMENT WILL BE REACTED BETWEEN THE SKIN & LOWER RING. COUPLE LOAD IS

$P' = \frac{M}{2.5} = 74.2^{\#}$

THE INDUCED LOAD P' IN THE RING IS TRANSFERRED TO THE DUCT SIDE WALL, & IS SHEARED DOWN TO THE SKIN. THE LOAD P' ACTS ON THE RING IN THE OPPOSITE DIRECTION FROM THE PRESSURE LOAD. THIS WILL TEND TO REDUCE THE RING BENDING MOMENT SHOWN ON SHT. 64.

ASSUMING THAT P' IS REACTED BY THE DUCT WALL IN A SINUSOIDAL DISTRIBUTION, THE MAXIMUM SHEAR WILL OCCUR AT THE CENTER OF THE ROUNDED ENDS OF THE DUCT & WILL HAVE A MAGNITUDE OF 11.8 #/".

$f_s = \frac{11.8}{.032} = 368$ PSI

IF THIS IS ADDED TO THE STRESS FOUND ON SHT. 6.9, THE TOTAL STRESS IS

$f_{S_{TOT}} = 725 + 368 = 1093$ PSI $\qquad MS = \frac{3049}{1093} - 1 > 1$

FORM 1319A

AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT:		REPORT No. 7/0558/67
C 105	ONE-WAY COOLING AIR VENTS DWG 7-0158-290	SHEET No. 6.11
		PREPARED BY: KAUTT — DATE: 2/16/56
		CHECKED BY: — DATE:

SECTION C-C (CONT.)

AS THE SHEAR LOAD OF 74.2#, INTRODUCED INTO THE DUCT BY THE RING, IS TRANSFERRED DOWN TO BE REACTED BY THE SKIN, A MOMENT OF 74.1 x 2.5 = 185.5 "# IS INDUCED IN THE DUCT. THIS MOMENT WILL BE REACTED BY THE FRAMES AS A COUPLE. THIS COUPLE LOAD IS

$$P'' = \frac{185.5}{4.8} = 39.7\#$$

P" WILL REDUCE THE LOAD ON FRAME 678.05 & ADD TO THE LOAD ON FRAME 668.45. THE FRAME LOADS WILL THEN BE:

FRAME 678.05 ~ 244 - 39.7 = 204.3#
" 673.25 ~ 488#
" 668.45 ~ 244 + 39.7 = 283.7#

FORM 1319A

AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT:		REPORT No. 7/0558/67	
		SHEET No. 6.12	
C 105	PRESSURE VENT DOORS 5 & 6 DWG 7-1058-5755	PREPARED BY	DATE
		KAUTT	5/18/56
		CHECKED BY	DATE

THE ANALYSIS OF DOORS 5 & 6 IS THE SAME AS FOR DOORS 7 & 8, SHEETS 6.1 & 6.2, EXCEPT THAT THE 1.88" DIMENSION IS 3.36", & THE NORMAL PRESSURE ON THE DOOR IS 16.65 PSI ULT (REF. M. SEVIK)

$A = (2)(1.76)(3.36) + (.5)(1.76)^2\pi = 16.7''^2$

$W = PA = 16.65 \times 16.7 = 278^\#$

SINCE THE TOTAL LOAD W IS LESS THAN FOR DOORS 7 & 8, WHICH IS 286# (REF. SHT. 6.1) THE PERIMETER LOADING WILL BE LESS, & THE HINGE IS OK BY COMPARISON.

CHECK OF DOOR AS RECTANGULAR PLATE

FROM ROARK, 2nd EDITION CASE 36, Pg 197, THE MAXIMUM STRESS IS:

$$S_b = \frac{-.75\, w\, b^2}{t^2(1 + 1.61\alpha^3)}$$

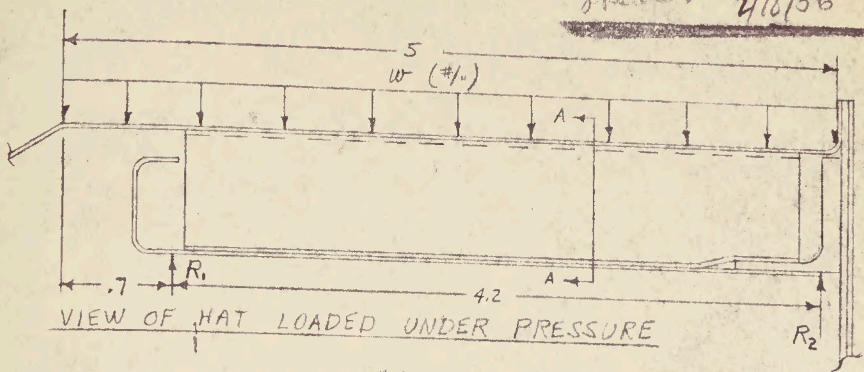
WHERE: $w = 16.65$ PSIU
$b = 2 \times 1.76 = 3.52''$
$a = 1.76 + 3.36 = 5.12''$
$t = .051''$
$\alpha = b/a = 3.52/5.12 = .688$

$$S_b = \frac{(-.75)(16.65)(3.52)^2}{(.051)^2\left[1 + (1.61)(.688)^3\right]} = \frac{154.6}{.00345} = 44800 \text{ PSI}$$

FORM 1319A

VENTS 7 & 8 (CONT)

obsolete 2/10/56



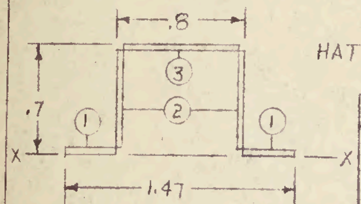
VIEW OF HAT LOADED UNDER PRESSURE

TOTAL SIDE LOAD = 93.2 #/". ASSUMING THAT 50% GOES TO EACH HAT SECTION;

$$w = 93.2 \times .5 = 46.6 \ \#/"$$

$$R_1 = \frac{(5)(46.6)(2.5-.1)}{4.2} = 133^{\#} \qquad R_2 = (5)(46.6) - 133 = 100^{\#}$$

MAXIMUM MOMENT ON HAT SECTION = 108 "#



HAT IS MADE FROM .040 75S-T6

ITEM	A	Y	AY	AY²	Io
1	.0268	.02	.00054	.00001	—
2	.0496	.35	.01736	.00608	.00159
3	.0288	.68	.01958	.01332	—
Σ	.1052	—	.03748	.01941	.00159

$$\bar{y} = \frac{.03748}{.1052} = .356" \qquad I = .02100 - .01335 = .00765"^4$$

$$f_t = \frac{108 \times .356}{.00765} = 5026 \text{ PSIU} \qquad MS = \text{HIGH}$$

$$f_c = \frac{108 \times .344}{.00765} = 4856 \text{ PSIU}$$

CRIPPLING OF ITEM (3)

$$\frac{b}{t} = \frac{.62}{.04} = 15.5$$

F_{cc} = 44500 PSI REF LOCKHEED SB 1151 MS = HIGH

AVRO AIRCRAFT LIMITED
MALTON · ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT: C 105	AIR VENTS	REPORT NO. 7/0555/67	SHEET NO 7.0
		PREPARED BY: KAUTT	DATE: 5/25/56
		CHECKED BY	DATE

SECTION 7

SPRINGS

FLAT & COILED

DWG 7-1058-6413
DWG 7-1058-6415

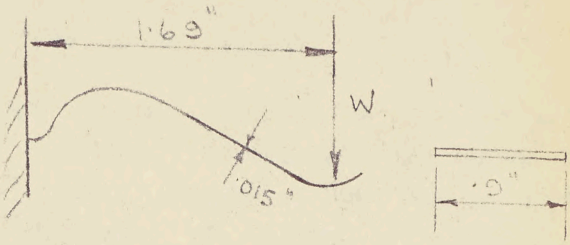
ORM 1313A

AVRO AIRCRAFT LIMITED
MALTON · ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT: C.105	SPRING – FLAT DRG Nº 7-1058-6415	REPORT No. 7/0558/67 SHEET No. 7.1	
		PREPARED BY: A.J. QUIGLEY	DATE: MAY 1956
		CHECKED BY:	DATE:

TO FIND SPRING CONSTANT ASSUMING THAT ONE HALF OF THE SPRING IS BUILT IN AT THE HINGE

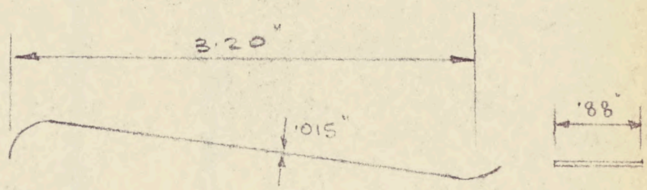
SPRING Nº 1



$$\delta = \frac{1}{3}\frac{W l^3}{EI} \qquad \frac{W}{\delta} = \frac{3EI}{l^3} = \frac{3 \times 30\times10^6 \times \cdot9 \times \cdot015^3}{12 \times 1{\cdot}69^3}$$

$$\therefore \frac{W}{\delta} = 4{\cdot}71 \text{ LB/IN}$$

SPRING Nº 2
REF DRG 7-1058-7275



$$\delta = \frac{1/3 W L^3}{EI} \qquad \frac{W}{\delta} = \frac{3EI}{l^3} = \frac{3 \times 30\times10^6 \times \cdot88 \times \cdot015^3}{12 \times 3{\cdot}2^3}$$

$$W/\delta = \cdot678 \text{ LB}$$

FORM 1319A

AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

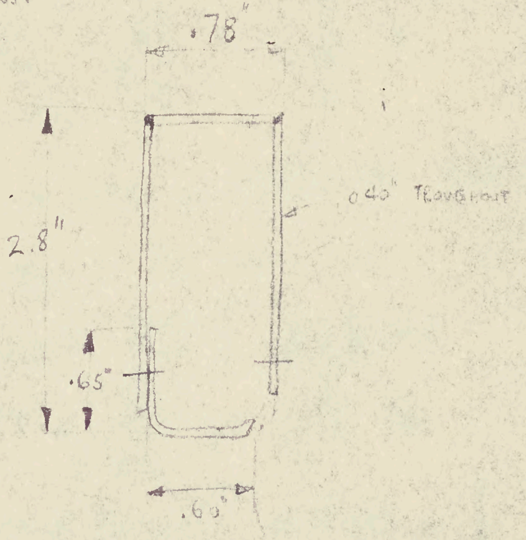
AIRCRAFT:		REPORT No. 7/0558/67	
C.105	CUT-OUTS FOR ONE WAY AIR COOLING VALVES #3 & #4 VENTS	SHEET No. 3.8	
		PREPARED BY	DATE
		[illegible signature]	JAN 58
		CHECKED BY	DATE

MEMBER EB IS SUBJECTED TO AN END LOAD AND A MOMENT DUE TO ECCENTRICITY. AGAIN THE STRESSES PRODUCED BY THE MOMENT RELIEVE THOSE DUE TO THE END LOAD AND HENCE THE STEEL & SKIN ARE O.K.

$$\text{MOMENT} = .24 \times 13070 = 3140 \text{ LB-IN (ULT)}$$

THIS MOMENT IS LOCALIZED IN THE REGION OF THE CUT-OUT ONLY. THIS REGION IS ALREADY REINFORCED BY VIRTUE OF DESIGN REQUIREMENTS OTHER THAN STRESS. USE CAN BE MADE THEREFORE, OF AVAILABLE MATERIAL TO CARRY THIS ADDITIONAL B.M.

THE MATERIAL ADDED (FOR PURPOSES OTHER THAN STRENGTH REQUIREMENTS) IS AS FOLLOWS:



$$I = \frac{1}{12} \times .78 \times (2.8)^3 - \frac{1}{12} \times .70 \times (2.72)^3$$

$$= \frac{1}{12}\left[.78 \times 21.9520 - .70 \times 20.1236\right] = \frac{3.036}{12} = .253''^4$$

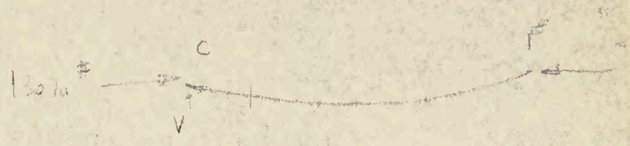
$$f = \frac{3140 \times 1.4}{.253} = 17400 \text{ LB/in}^2 \quad \text{O.K.}$$

FORM 1319A

AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT:			
C 105	Cut - Outs for One Way Air Cooling Valves #3 & #4 Vents	REPORT No. 7/0558/67	SHEET No. 3.9
		PREPARED BY [illegible]	DATE Feb 56
		CHECKED BY	DATE

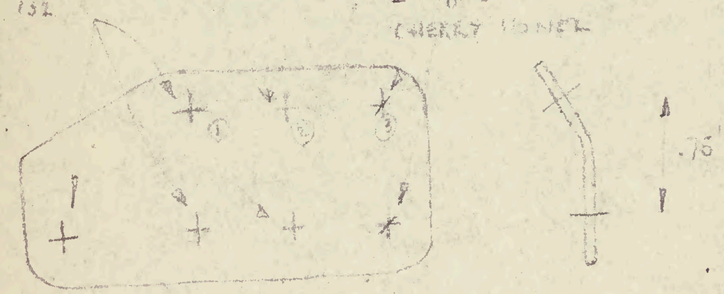
CLIPS AT CORNERS OF DIAGONAL MEMBERS:



V = 13070 × sin 7.9° = 13070 × .13744 = 1794 LBS (ULT)

5/32" AN 470

2 - 1/8" DIA
CHERRY RIVETS

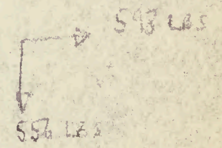


MOMENT DUE TO OFFSET = 1794 × .375 = 674 LB IN

CONSIDER RIVETS 1, 2 & 3

VERT LOAD = $\frac{1794}{2 \times 3}$ = $\frac{598}{2}$ LBS

DUE TO MOMENT = $\frac{674}{2 \times 1.21}$ = $\frac{556}{2}$ LBS



VECTORIAL SUM = 816 LBS = 408 LBS

ALLOW. LOAD ON A 1/8" CHERRY [illegible]
[illegible] IN .051" MATERIAL IS [illegible] LBS

ALLOW. BEARING [illegible] = .655 × 1.37 × .80 = 719 LBS
(.051 MATERIAL)

FORM 1319A

AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT:		REPORT NO. 7/0558/67	
C.105	CUT-OUTS FOR ONE WAY AIR COOLING VALVES & 3.5" VENTS	SHEET NO. 3.10	
		PREPARED BY [signature]	DATE FEB 58
		CHECKED BY	DATE

ALLOW. LOAD ON 5/32 AN 470 = 596 × .996 × .90 =

AT 260°F = 535 LBS (SHEAR)

$$M.S. = \frac{535}{408} - 1 = .31$$

* N.B. AN END LOAD OF 15100 LBS SHOULD HAVE BEEN TAKEN. THIS HIGHER LOAD ALTERS THE RIVET LOAD FROM 408 LBS TO 472 LBS

$$M.S. = \frac{535}{472} - 1 = .13$$

O.K.

FORM 1319A

AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

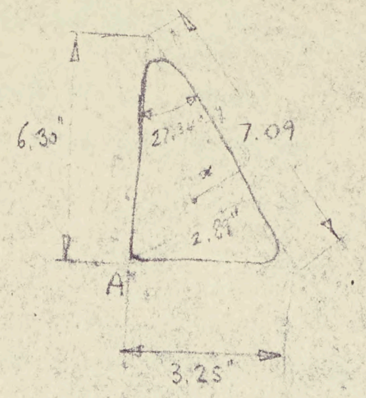
AIRCRAFT: C.105	ONE WAY COOLING AIR VALVES	REPORT NO. 7/0558/67	SHEET NO. 3.11
		PREPARED BY [signature]	DATE JAN 58
		CHECKED BY	DATE

MAX. PRESSURE ON DOORS = 16.65 LB/$\square$" (ULT)

DOOR AREA = 10.25 $\square$" (GROSS)

TOTAL FORCE = 170.5 LBS

x = 1.23" TO C.P.



TO FIND THE MAX. LOAD ON THE HINGES IT WILL BE ASSUMED THAT THE DOOR IS SUPPORTED ON THE HINGES AND ON ONE CORNER AT 'A'.

$$\text{HINGE LOAD} = \frac{1.66 \times 170.5}{2.89} = 98.0 \text{ LBS (ULT)}$$

DIVIDING THIS EQUALLY ON THE TWO HINGES, LOAD PER HINGE = 49.0 LBS (ULT)

FORM 1319A

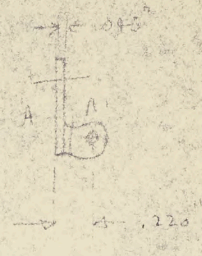
AVRO AIRCRAFT LIMITED
MALTON · ONTARIO
TECHNICAL DEPARTMENT

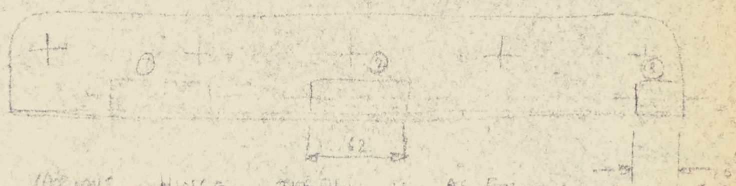
AIRCRAFT:		REPORT NO. 7/0558/67	
C.105	ONE WAY COOLING AIR VALVES	SHEET NO. 3.12	
		PREPARED BY	DATE
		M. SEVIK	MAY 58
		CHECKED BY	DATE

A CONTINUOUS HINGE IS PROVIDED AS SHOWN ON DRAWINGS 7-1058-5783/4 AND 7-1058-5783/4.

LOAD ON HINGE IS 98# (ULT.)

OWING TO THE PRESENCE OF THE SPRING THERE IS A GAP IN THE HINGE LINE AS SKETCHED.





THE LOAD ON THE VARIOUS HINGE TEETH IS AS FOLLOWS

① → $\frac{1.58}{4.40} \times 98 = 35.3^{\#}$

② → $\frac{1.73}{4.40} \times 98 = 38.6^{\#}$

③ → $\frac{1.09}{4.40} \times 98 = 24.2^{\#}$

CONSIDER HINGE #3 —

B.M. AT ROOT = $24.2 \times .18 = 4.35^{\#-"}$

$I = \frac{1}{12} \times .3 \times (.17)^3 = .1235 \times 10^{-3} \ "^4$

$f = 4.35 \times \frac{.085}{.123} \times 1000 = 3000 \ ^{\#}/_{\square"}$ O.K.

CONSIDER SECTION AA — SAY .5" EFFECTIVE NEAR HINGE ③

$f = \frac{6M}{bt^2} = \frac{6 \times 24.2 \times .22}{.5 \times (.04)^2} = 39900 \ ^{\#}/_{\square"}$ O.K.

FORM 1319A

AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT:		REPORT NO. 7/0558/67	
C-105	ONE WAY AIR COOLING VALVES	SHEET NO. 3.13	
		PREPARED BY	DATE
		M. SEVIK	MAY 56
		CHECKED BY	DATE

THE PIN CONNECTING DOOR TO BEAM IS TO 2CS-P-112.

MAT — COR. RES STEEL WIRE [AN-W-24 COND. 'B' OR MIL W-6713]

DIA. OF PIN IS $.090^{+.000}_{-.002}$

PIN AREA (MIN. TOL.) $= \frac{\pi}{4}(.088)^2 = .00608 \text{ in}^2$

NOMINAL SHEAR STRESS (AT HINGE ③) $= \frac{38.5}{.00608} = 6340 \ \#/\text{in}^2$ [illegible] (THIS STRESS WILL BE LARGER OWING TO BUCKLING)

PIN BENDING

$I = 2.94 \times 10^{-6} \text{ in}^4$

ALLOWABLE (BENDING) $f = 1.60 \times 225000 = 360000 \ \#/\text{in}^2$

ALLOWABLE $M = \frac{360000 \times 2.94 \times 10^{-6}}{.044} = 24.7 \ \#''$

REFERRING TO THE SKETCH IT IS APPARENT THAT THE WORST CONDITION WILL OCCUR AT HINGE ②. IT IS ALSO OBVIOUS THAT THE VALUE OF THE $b^{\prime\prime}$ CANNOT EXCEED THE ALLOWABLE.

AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT:		REPORT NO. 7/0558/67	
C 105	AIR VENTS	SHEET NO. 4.0	
		PREPARED BY	DATE
		KAUTT	5/25/56
		CHECKED BY	DATE

SECTION 4

STRESSING

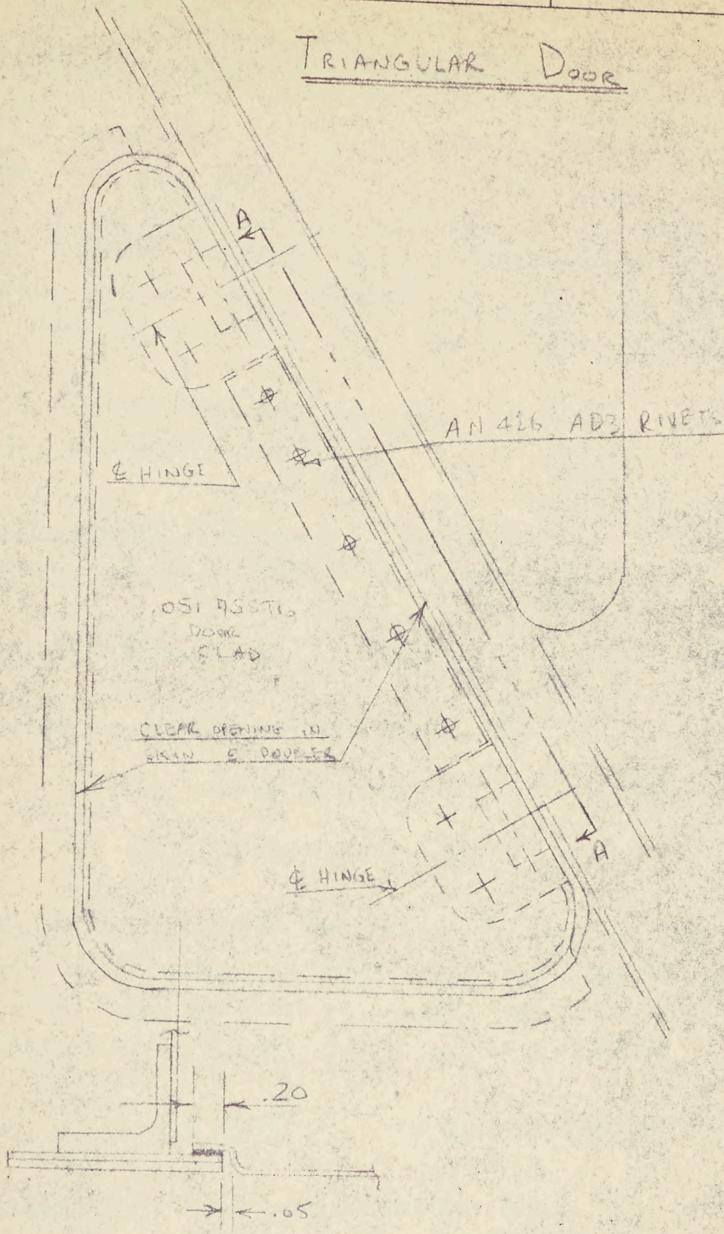
TRIANGULAR DOOR

SEE DWG 7-1058-5105/6
5075/6

FORM 1319A

A. V. ROE CANADA LIMITED MALTON - ONTARIO **TECHNICAL DEPARTMENT (Aircraft)**		REPORT NO. 7/0558/67 SHEET NO. 4.1	
AIRCRAFT: C-105		PREPARED BY R. MELVILLE	DATE 9 FEB 1956
		CHECKED BY	DATE

TRIANGULAR DOOR



FOR VIEW A-A
SEE P. 4-7

FORM 1319A

TRIANGULAR DOOR (CONTINUED)

IT IS REQUIRED TO FIND THE STRESSES IN THE TRIANGULAR DOOR SHOWN ON THE PREVIOUS PAGE. THE DOOR SURFACE, WHICH IS CURVED SLIGHTLY, WILL BE ASSUMED TO BE FLAT.

THE SHAPE OF THE DOOR, APPROXIMATES TWO DIFFERENT SHAPES FOR WHICH THE STRESSES CAN EASILY BE FOUND, THE MAXIMUM DOOR STRESS WILL BE FOUND BY ASSUMING THAT THE DOOR IS

1) A RIGHT ANGLE ISOSCELES TRIANGLE AND
2) A CIRCULAR SECTOR.

1) RIGHT ANGLE ISOSCELES TRIANGLE

(REFERENCE ROARK, TABLE X CASE 66)

$$\text{Max } S = \text{Max } S_x = .131 \frac{w a^2}{t^2} \quad \text{IF } \nu \text{ IS TAKEN AS } .3$$

AND WHERE w = UNIT APPLIED LOAD, #/IN²

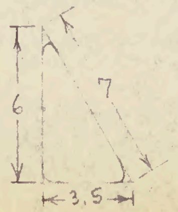
a = LENGTH OF ONE OF THE EQUAL SIDES, INCHES

t = THICKNESS OF PLATE, INCHES

A CHECK WILL FIRST BE MADE TO SEE IF THE DEFLECTION REQUIREMENT IS FULFILLED. THAT IS, THE DERIVATIONS ARE BASED UPON THE ASSUMPTIONS THAT THE DEFLECTION DOES NOT EXCEED ½ THE THICKNESS OF THE PLATE.

$$\text{Max } y = .0095 \frac{w a^4}{E t^3} \quad \text{WHERE } E = \text{MODULUS OF ELASTICITY } \#/\text{IN}^2$$

THE DIMENSIONS OF THE PLATE ARE:



TRIANGULAR DOOR (CONTINUED)

THE DEFLECTION IS A MAXIMUM WHEN "a" IS A MAXIMUM.
∴ LET a = 6 IN.

$w = 16\ \#/in^2$ $t = .051$ IN $E = 1.03 \times 10^7\ \#/in^2\ (.923) = 9.51 \times 10^6\ \#/in^2$ (TEMP. CORRECTION)

$$\text{MAX } y = .0095\ \frac{16\ \#/in^2\ (6\ in)^4}{9.51 \times 10^6\ \#/in^2\ (.051\ in)^3} = .155 \text{ IN}$$

THE DEFLECTION IS TOO GREAT FOR ACCURATE ANSWERS FROM THE DERIVED FORMULAS. THE DEFLECTION SHOULD NOT BE GREATER THAN $\frac{t}{2} = \frac{.051}{2} = .0255$ IN

IF a = 3.5 IN. $\text{MAX } y = .155\ in\left(\frac{3.5^4}{1300}\right) = .0179$ IN O.K.

BY REFERRING TO THE SECOND PARAGRAPH IN ARTICLE 58 OF ROARK WE SEE THAT IT WOULD BE CONSERVATIVE TO CALCULATE THE , DUE TO THE GIVEN LOAD, ACCORDING TO ORDINARY THEORY. THIS IS BECAUSE THE DEFLECTION IS SO LARGE.

THE MAXIMUM STRESSES WILL BE CALCULATED FOR BOTH THE a = 6 INCH CASE AND THE a = 3.5 INCH CASE.

FOR a = 6 INCHES

$$\text{MAX } S = \text{MAX } S_x = .131\ \frac{w a^2}{t^2} = .131\ \frac{16\ \#/in^2\ (6\ in)^2}{(.051\ in)^2}$$

MAX S = 29 000 PSI

FOR a = 3.5 INCHES

$$\text{MAX } S = 29000\ \left(\frac{3.5^2}{36}\right) = \underline{9900 \text{ PSI}}$$

A. V. ROE CANADA LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT (Aircraft)

REPORT NO.	7/0558/67
SHEET NO.	4.4
AIRCRAFT: C-105	
PREPARED BY: R. MELVILLE	DATE: 9 FEB. 1956
CHECKED BY:	DATE:

TRIANGULAR DOOR (CONTINUED)

2) CIRCULAR SECTOR (REF. ROARK, TABLE X CASE 67)

AGAIN THE DEFLECTION WILL BE TESTED, FIRST.

$$\text{MAX } y = \alpha \frac{w a^4}{E t^3}$$

WHERE a = RADIUS OF CIRCULAR SECTOR

α = COEFFICIENT GIVEN BY TABLE IN THE REFERENCE LISTED ABOVE.

$\theta = 30°$ SINCE α FOR $\theta = 30°$ IS NOT GIVEN, WE WILL USE α FOR $\theta = 45°$ $\alpha = .0054$

$$\text{MAX } y = \alpha \frac{w a^4}{E t^3} = .0054 \frac{16\ \#/\text{IN}^2\ (6\ \text{IN})^4}{9.51 \times 10^6\ \#/\text{IN}^2\ (.051)^3} = .088\ \text{IN}$$

DEFLECTION IS LARGER $\frac{t}{2}$

A PLOT OF α VS. θ IS SHOWN ON THE FOLLOWING PAGE. EXTRAPOLATING THE CURVE OF α TO ZERO GIVES A VALUE OF $\alpha = .003$. THEN

$$\text{MAX } y = .088 \left(\frac{.003}{.0054}\right) = .049\ \text{IN}$$

DEFLECTION STILL TOO LARGE.

IT IS OBVIOUS THAT IF 7 INCHES WERE USED FOR "a" THE DEFLECTION WOULD EVEN BE LARGER, HOWEVER AS EXPLAINED ABOVE, THE CALCULATED STRESSES WILL BE LARGER THAN THE ACTUAL STRESSES.

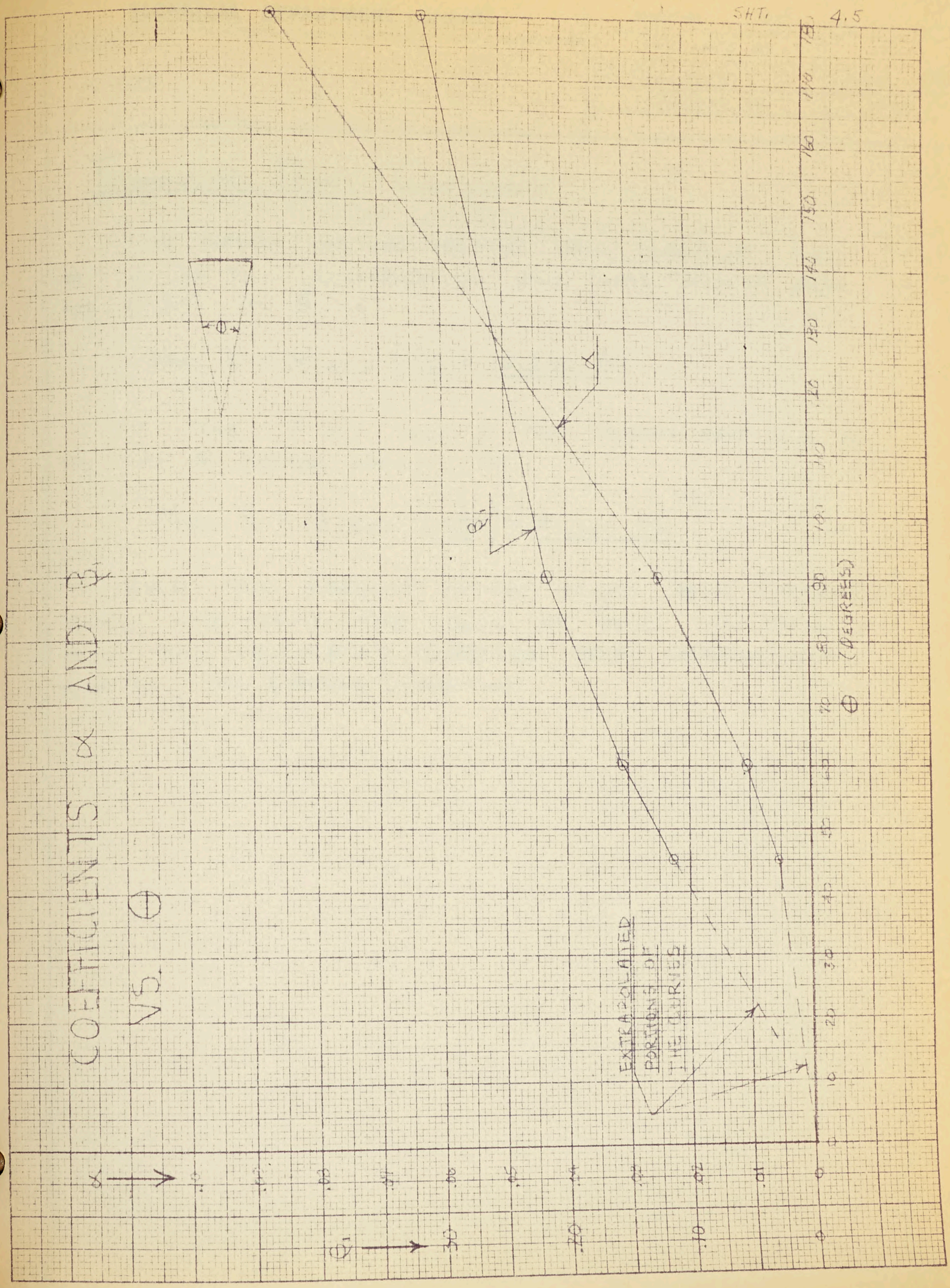
$$\text{MAX } S = \text{MAX } S_t = \text{MAX. TANGENTIAL STRESS} \quad (\text{FOR } \theta = 45°)$$

$$\text{MAX } S = \beta_1 \frac{w a^2}{t^2} = .114 \frac{16\ \#/\text{IN}^2\ (6\ \text{IN})^2}{(.051\ \text{IN})^2} = \underline{25,300\ \text{PSI}}$$

FORM 1319A

RPT 7/0558/67

R. MELVILLE
10 FEB 1956
SHT. 4.5



TRIANGULAR DOOR (CONTINUED)

THE GRAPH ON THE PREVIOUS PAGE SHOWS A PLOT OF β_1 VS. θ. EXTRAPOLATING THIS CURVE GIVES A VALUE FOR $\theta = 30°$ OF $\beta_1 = .07$

$$\text{MAX } S = 25{,}300 \left(\frac{.07}{.114}\right) = \underline{15{,}500 \text{ PSI}}$$

IF THE 7 INCH SIDE OF THE TRIANGLE WERE USED AS THE CIRCULAR SECTOR RADIUS, THE

$$\text{MAX } S = 15{,}500 \left(\frac{7^2}{36}\right) = \underline{21{,}100 \text{ PSI}}$$

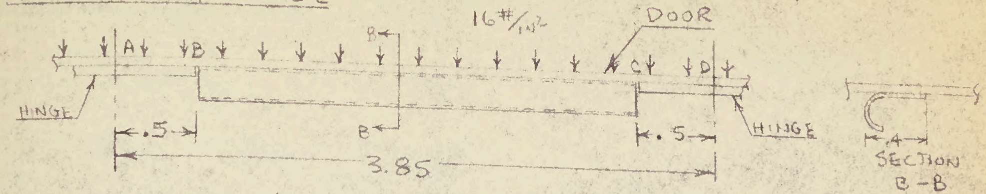
EVEN THE LARGEST OF THE VALUES ABOVE (29,000 PSI) WOULD NOT CAUSE THE DOOR TO FAIL. IN EACH CASE THE CALCULATED STRESSES ARE CONSERVATIVELY HIGH. (DUE TO EXCESSIVE DEFLECTION)

A. V. ROE CANADA LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT (Aircraft)

AIRCRAFT:		REPORT NO. 7/0558/67	
C-105		SHEET NO. 4.7	
		PREPARED BY	DATE
		R. MELVILLE	10 FEB 1956
		CHECKED BY	DATE

TRIANGULAR DOOR (CONTINUED)

UNSUPPORTED SIDE



VIEW A-A (REF. P. 4.1)

THE PART OF THE DOOR BETWEEN THE TWO HINGES IS UNSUPPORTED.

CONSIDERING THAT PART OF THE DOOR AS A BEAM (BETWEEN POINTS "A" AND "D"), THERE WILL BE CRITICAL POINTS AT "B" AND "C". THE STRESSES AT POINTS "B" AND "C" WILL BE INVESTIGATED, ASSUMING FIRST 100% FIXITY AT POINTS "A" AND "D", AND SECOND ASSUMING A PIN JOINT.

SIMPLY SUPPORTED

MOMENT AT POINT "B"

$$M_x = \frac{w l x}{2} - \frac{w x^2}{2} = \frac{16(3.85)(.5)}{2} - \frac{16(.5)^2}{2}$$

$$= 13.4 \text{ IN-\#}$$

FIXED

MOMENT AT POINT "B"

$$M_x = \frac{w l^2}{2}\left(\frac{1}{6} - \frac{x}{l} + \frac{x^2}{l^2}\right) = \frac{16(3.85)^2}{2}\left(\frac{1}{6} - \frac{.5}{3.85} + \frac{.5^2}{3.85^2}\right)$$

$$M_x = 6.36 \text{ IN-\#}$$

FORM 1319A

92-7

A. V. ROE CANADA LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7/0558/67
SHEET NO. 4.8

AIRCRAFT: C-105

PREPARED BY: R. MELVILLE — DATE: 10 FEB 1956
CHECKED BY: — DATE:

TRIANGULAR DOOR (CONTINUED)

UNSUPPORTED SIDE (CONTINUED)

THE STRESS WILL BE

A) FOR SIMPLE SUPPORT

$$f = \frac{Mc}{I} = \frac{M\frac{t}{2}}{\frac{bt^3}{12}} = \frac{6M}{bt^2} = \frac{6\,(13.4)}{.4\,(.051)^2} = 77000 \text{ PSI}$$

B) FOR FIXED

$$f = 77{,}000\left(\frac{6.36}{13.4}\right) = 36{,}500 \text{ PSI}$$

ASSUME A 50% FIXITY

THE STRESS IS:

$$f = [77000 - 36{,}500(.50)] + 36{,}500$$

$$= 56{,}750 \text{ PSI}$$

$$F_{TU} = 72{,}000(.795) = 57{,}100$$

$$M.S. = \frac{57{,}100}{56{,}750} - 1 = .01$$

FORM 1319 A

A. V. ROE CANADA LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT (Aircraft)

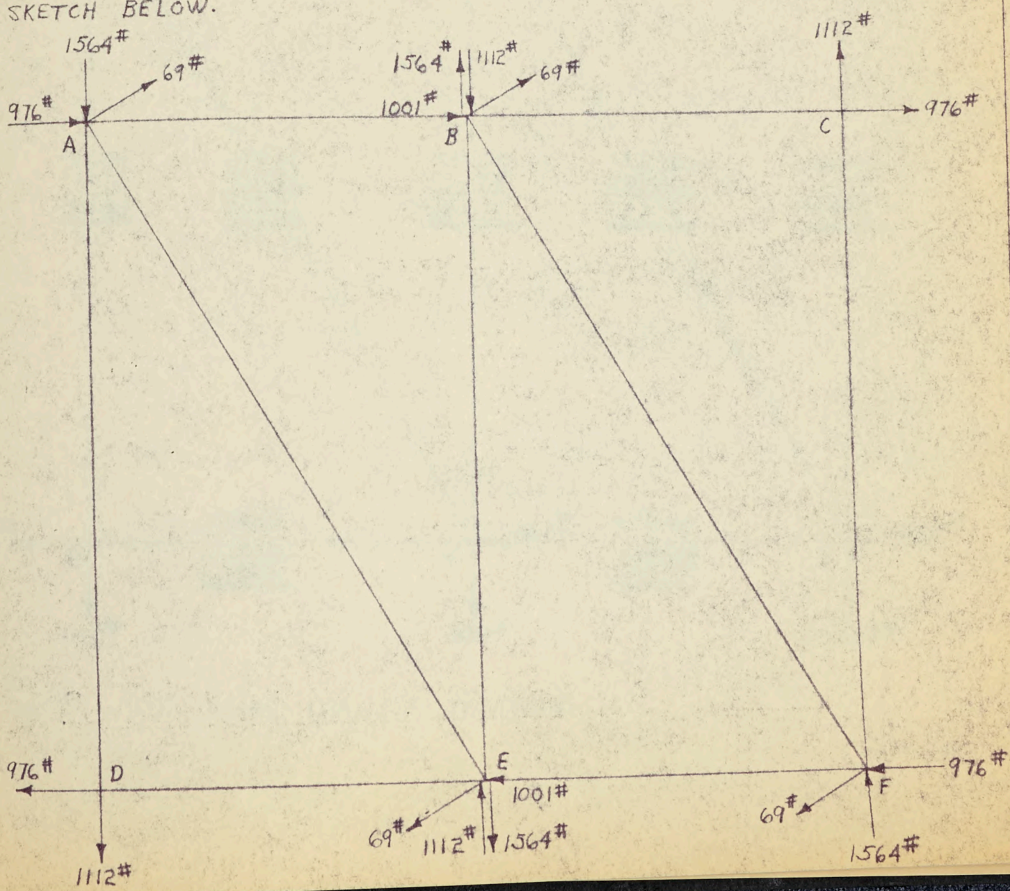
AIRCRAFT:		REPORT NO. 7/0558/67
C 105	ONE-WAY COOLING AIR VALVES DWG 7-0158-353	SHEET NO. 2.14
		PREPARED BY: KAUTT — DATE: 2/7/56
		CHECKED BY: — DATE:

CHANGE IN TRUSS AXIAL LOADS (CONT)

THE MOMENTS SHOWN ON SHT 2.13 ARE CONVERTED TO COUPLE LOADS IN THE TABLE BELOW.

MEMBER	M_1	M_2	$M_1 + M_2$	L	$(M_1+M_2)/L = P_c$
CF	3795	4258	8053.	8.250	976
BC	-1543	-3795	-5338	4.800	-1112
BF	368	291	659	9.545	69
EF	-2956	-4549	-7505	4.800	-1564
DE	-3795	-1543	-5338	4.800	-1112
AB	-4549	-2956	-7505	4.800	-1564
BE	4131	4131	8262	8.250	1001
AD	4258	3795	8053	8.250	976
AE	291	368	659	9.545	69

THE COUPLE LOADS ACTING ON THE JOINTS ARE SHOWN IN THE SKETCH BELOW.



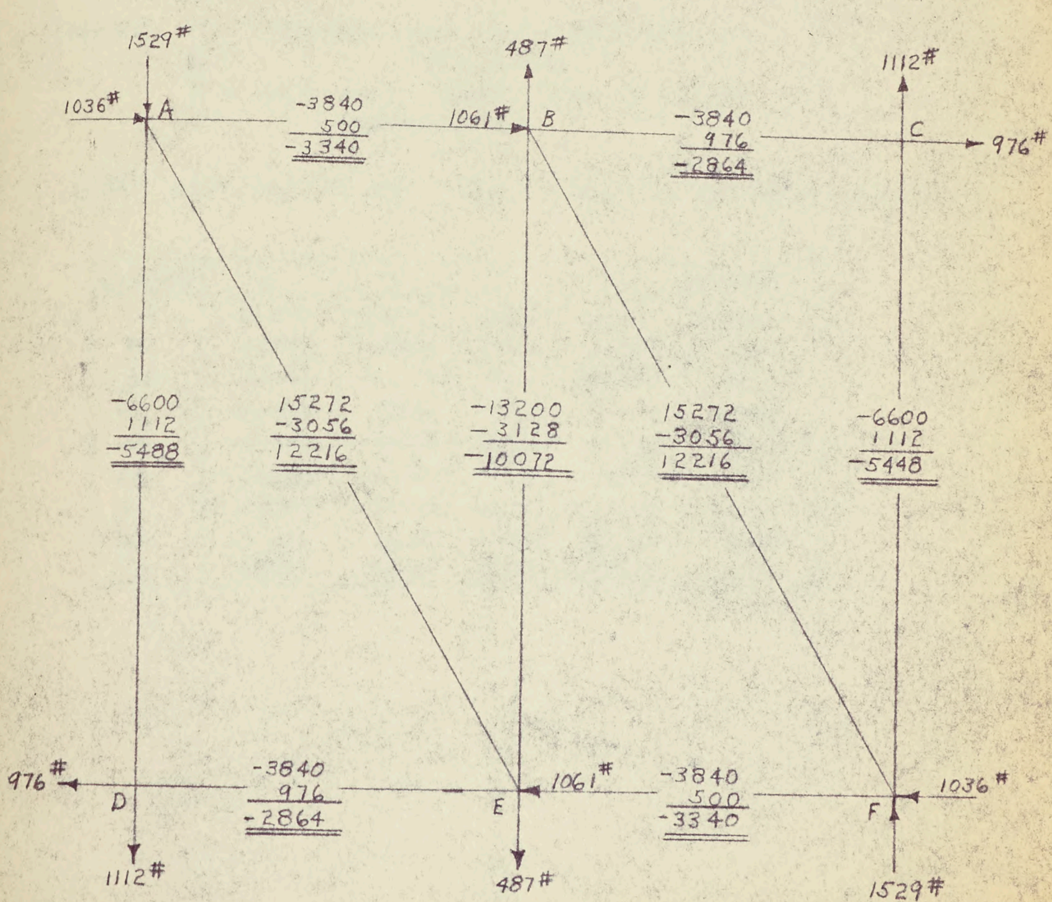
FORM 1319 A

A. V. ROE CANADA LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT (Aircraft)

AIRCRAFT: C 105	ONE-WAY COOLING AIR VENTS DWG 7-0158-353	REPORT NO. 7/0558/67
		SHEET NO. 2.15
		PREPARED BY: KAUTT — DATE: 2/7/56
		CHECKED BY: — DATE:

CHANGE IN TRUSS AXIAL LOADS (CONT.)

THE JOINT LOADS SHOWN ON SHT. 2.14 ARE RESOLVED INTO HORIZONTAL & VERTICAL COMPONENTS & SUMMED UP AT EACH JOINT. THESE VALUES ARE SHOWN IN THE SKETCH BELOW. FROM THESE LOADS, CORRECTING AXIAL LOADS ARE FOUND & SUPERIMPOSED ON THE ORIGINAL LOADS. THESE ARE ALSO SHOWN ON THE SKETCH BELOW. THE TOP NUMBER IS THE ORIGINAL AXIAL LOAD (REF. SHT. 2.7) THE MIDDLE NUMBER IS THE CORRECTING LOAD DUE TO MOMENT, & THE LOWER NUMBER (UNDERSCORED) IS THE RESULTANT, (OR CORRECT) AXIAL LOAD.



NOTE: PLUS AXIAL LOAD IS TENSION.

CHANGE IN TRUSS DEFLECTIONS

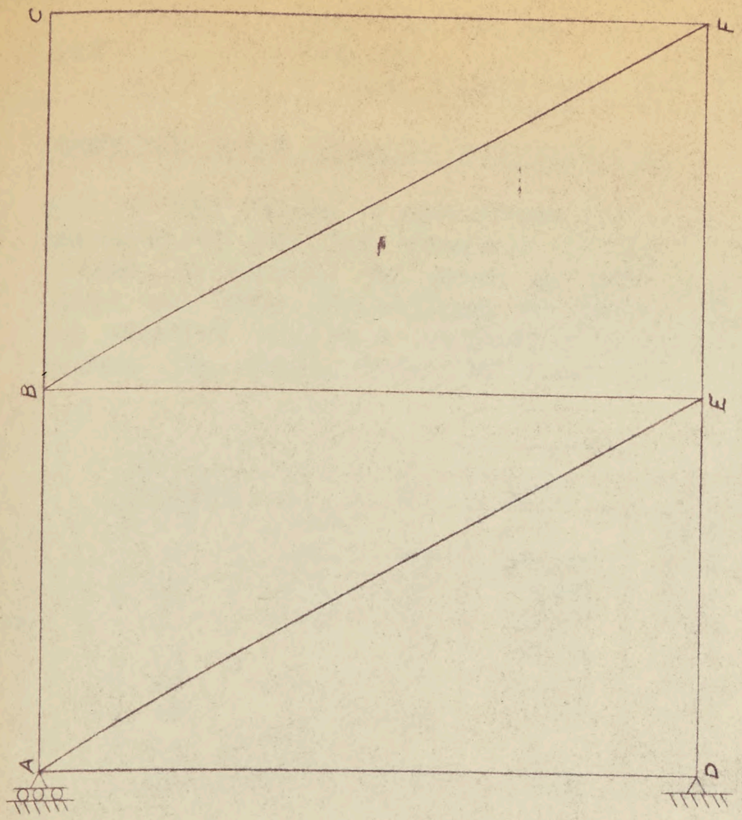
THE TRUSS AXIAL LOADS (SHT. 2.15) ARE CHANGED ENOUGH BY THE JOINT STIFFNESS TO WARRANT FURTHER INVESTIGATION INTO THE TRUSS DEFLECTIONS. THIS IS DONE BY MEANS OF ANOTHER WILLIOT DIAGRAM (REF. SHTS. 2.5 - 2.8). SINCE A, L, & E REMAIN THE SAME, THE DEFORMATIONS OF THE TRUSS WILL BE IN THE RATIO OF THEIR AXIAL LOADS. THUS:

$$\Delta' = \frac{P'\Delta}{P}$$

WHERE: P = ORIGINAL AXIAL LOAD (REF. SHT. 2.7)
Δ = " DEFORMATION " " "
P' = NEW AXIAL LOAD (REF. SHT. 2.15)
Δ' = " DEFORMATION.

THESE NEW VALUES ARE SUMMARIZED IN THE TABLE BELOW.

MEMBER	Δ	P	P'	$P'\Delta$	$\Delta' = P'\Delta/P$
CF	-.01099	-6600	-5488	60.313	-.0091
BC	-.00553	-3840	-2864	15.838	-.0041
BF	.04141	15272	12216	505.865	.0331
EF	-.00553	-3840	-3340	18.470	-.0048
DE	-.00553	-3840	-2864	15.838	-.0041
AB	-.00553	-3840	-3340	18.470	-.0048
BE	-.02287	-13200	-10072	230.347	-.0175
AD	-.01099	-6600	-5488	60.313	-.0091
AE	.04141	15272	12216	505.865	.0331



WILLIOT DIAGRAM FOR
UNCORRECTED DEFLECTIONS

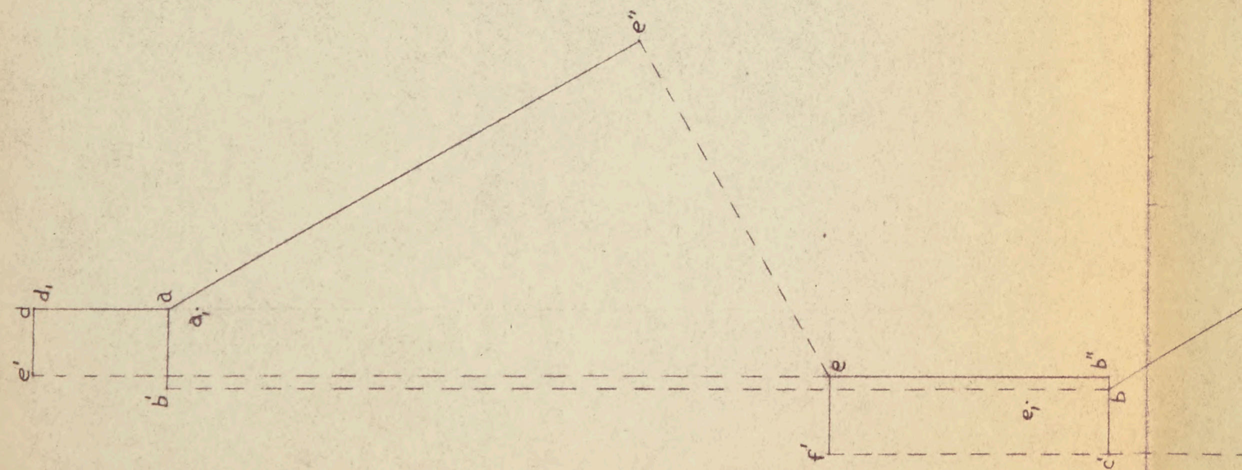
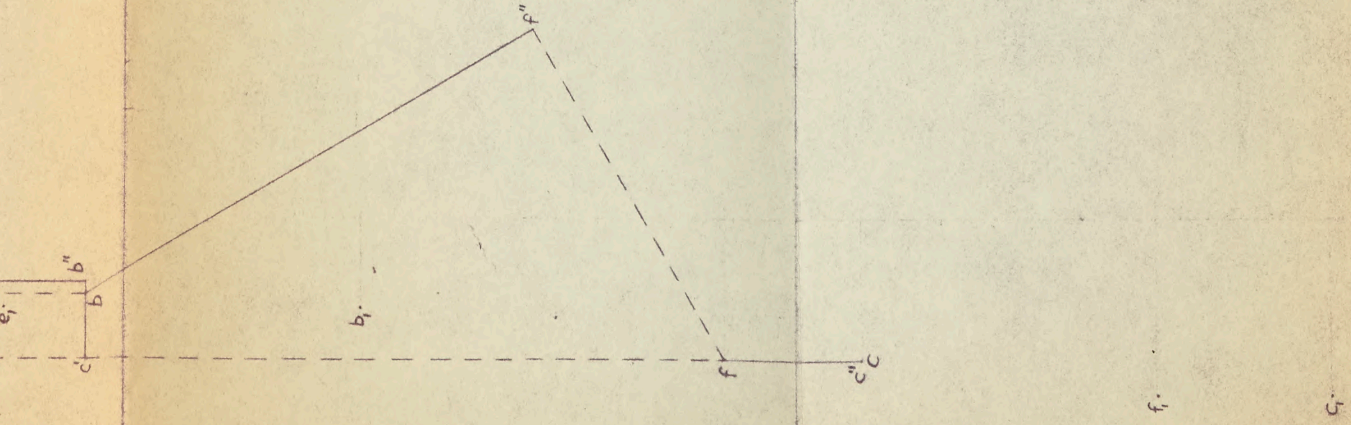


DIAGRAM FOR CORRECTED TRUSS DEFLECTIONS SCALE: 1" = .01"

…CTED DEFLECTIONS FROM SHT. 2.8 SHOWN FOR COMPARISON. (DENOTED BY SUBSCRIPT 1)



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

REPORT No. 7/0558/67
SHEET No. 2.18

AIRCRAFT:		PREPARED BY	DATE
C 105	ONE-WAY COOLING AIR VALVES DWG 7-0158-353	KAUTT	2/8/56
		CHECKED BY	DATE

CORRECTED JOINT MOMENT DISTRIBUTION

DUE TO THE CHANGE IN DEFLECTIONS (SHOWN IN THE WILLIOT DIAGRAM, SHT. 2.17) THE MOMENTS IN THE MEMBERS WILL CHANGE, THEREFORE, THE WORK OF SHTS 2.9-2.11 IS REPEATED, USING THE NEW DEFLECTIONS, TO OBTAIN THIS NEW DISTRIBUTION. THE RELATIVE STIFFNESS FACTORS & DISTRIBUTION FACTORS REMAIN THE SAME; ONLY THE FIXED-END MOMENTS CHANGE.

	1	2	3	4	5
MEMBER	I	δ *	$6EI\delta$	L^2	F.E.M
CF	.02778	0	0	68.06	0
BC	.02303	.0497	199,159	23.04	-8644
BF	.00238	.0239	9,897	91.10	-109
EF	.02303	.0581	232,819	23.04	-10105
DE	.02303	.0497	199,159	23.04	-8644
AB	.02303	.0581	232,819	23.04	-10105
BE	.01422	-.0007	-1,732	68.06	25
AD	.02778	0	0	68.06	0
AE	.00238	.0239	9,897	91.10	-109

* SCALED FROM WILLIOT DIAGRAM, SHT. 2.17

FORM 1319A

SOLUTION BY HARDY-CROSS FOR MOMENTS AT JOINTS (CORRECTED)

JOINT	A				B				
	1	2	3	4	5	6	7	8	9
MEMBER	AD	AE	AB		BA	BE	BF	BC	
DIST. FACTOR	.400	.030	.570		.415	.149	.021	.415	
	0	-109.0	-10105.0		-10105.0	25.0	-109.0	-8644.0	
	4085.6	306.4	5822.0		7815.7	2806.1	395.5	7815.7	
	+1780.7	+197.8	+3907.8		+2911.0	+1403.0	+153.2	+2541.3	
	-2354.5	-176.6	-3355.2		-2908.5	-1044.3	-147.2	-2908.5	
	-1225.8	-73.6	-1454.2		-1677.6	-522.2	-88.3	-1749.5	
	1101.4	82.6	1569.6		1675.6	601.6	84.8	1675.6	
	542.1	42.4	837.8		784.8	300.8	41.3	773.6	
	-568.9	-42.7	-810.7		-788.7	-283.2	-39.9	-788.7	
	-286.0	-20.0	-394.4		-405.4	-141.6	-21.4	-408.2	
	280.2	21.0	399.2		405.3	145.5	20.5	405.3	
	139.8	10.2	202.6		199.6	72.8	10.5	199.6	
	-141.0	-10.6	-201.0		-200.2	-71.9	-10.1	-200.2	
Σ	3353.6	227.9	-3581.5		-2293.4	3291.6	289.9	-1288.0	

JOINT		D				E			
MEMBER	DA		DE		ED	EA	EB	EF	
DIST. FACTOR	.412		.588		.415	.021	.149	.415	
	0		-8644.0		-8644.0	-109.0	25.0	-10105.0	
	3561.4		5082.6		7815.7	395.5	2806.1	7815.7	
	+2042.8		+3907.8		+2541.3	+153.2	+1403.0	+2911.0	
	-2451.6		-3499.0		-2908.5	-147.2	-1044.3	-2908.5	
	-1177.2		-1454.2		-1749.5	-88.3	-522.2	-1677.6	
	1084.2		1547.2		1675.6	84.8	601.6	1675.6	
	550.7		837.8		773.6	41.3	300.8	784.8	
	-572.1		-816.4		-788.7	-39.9	-283.2	-788.7	
	-284.4		-394.4		-408.2	-21.4	-141.6	-405.4	
	279.7		399.1		405.3	20.5	145.5	405.3	
	140.1		202.6		199.6	10.5	72.8	199.6	
	-141.2		-201.5		-200.2	-10.1	-71.9	-200.2	
Σ	3032.4		-3032.4		-1288.0	289.9	3291.6	-2293.4	

FORM 1543

OINTS (CORRECTED)

A. V. ROE CANADA LIMITED
MALTON, ONTARIO
TECHNICAL DEPT. (AIRFRAME)

AIRCRAFT - - C 105
WEIGHT - -
C. G. POSITION -

REPORT NO. - 7/0558/67
SHEET - - 2.19
DATE - - 2/8/56
PREPARED BY - KAUTT

6	7	8	9	10	11	12	13	14	15	16	17	18	19
B				C									
BE	BF	BC		CB		CF							
.149	.021	.415		.588		.412							
25.0	-109.0	-8644.0		-8644.0		0							
2806.1	395.5	7815.7		5082.6		3561.4							
+1403.0	+153.2	+2541.3		+3907.8		+2042.8							
-1044.3	-147.2	-2908.5		-3499.0		-2451.6							
-522.2	-88.3	-1749.5		-1454.2		-1177.2							
601.6	84.8	1675.6		1547.2		1084.2							
300.8	41.3	773.6		837.8		550.7							
-283.2	-39.9	-788.7		-816.4		-572.1							
-141.6	-21.4	-408.2		-394.4		-284.4							
145.5	20.5	405.3		399.1		279.7							
72.8	10.5	199.6		202.6		140.1							
-71.9	-10.1	-200.2		-201.5		-141.2							
3291.6	289.9	-1288.0		-3032.4		3032.4							
E					F								
EA	EB	EF		FE	FB	FC							
.021	.149	.415		.570	.030	.400							
-109.0	25.0	-10105.0		-10105.0	-109.0	0							
395.5	2806.1	7815.7		5822.0	306.4	4085.6							
+153.2	+1403.0	+2911.0		+3907.8	+197.8	+1780.7							
-147.2	-1044.3	-2908.5		-3355.2	-176.6	-2354.5							
-88.3	-522.2	-1677.6		-1454.2	-73.6	-1225.8							
84.8	601.6	1675.6		1569.6	82.6	1101.4							
41.3	300.8	784.8		837.8	42.4	542.1							
-39.9	-283.2	-788.7		-810.7	-42.7	-568.9							
-21.4	-141.6	-405.4		-394.4	-20.0	-286.0							
20.5	145.5	405.3		394.2	21.0	280.2							
10.5	72.8	199.6		202.6	10.2	139.8							
-10.1	-71.9	-200.2		-201.0	-10.6	-141.0							
289.9	3291.6	-2293.4		-3581.5	227.9	3353.6							

AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT: C 105	ONE-WAY COOLING AIR VALVES DWG 7-0158-353	REPORT NO. 7/0558/67	SHEET NO. 2.20
		PREPARED BY: KAUTT	DATE: 2/8/56
		CHECKED BY:	DATE:

SUMMARY OF MOMENTS IN MEMBERS

REF. SHT.	25	32
TRUSS* MEMBER	ORIGINAL** MOMENT	CORRECTED MOMENT**
AD	4258	3354
DA	3795	3032
AB	-4549	-3582
BA	-2956	-2293
AE	291	228
EA	368	290
BC	-1543	-1288
CB	-3795	-3032
BE	4131	3292
EB	4131	3292
BF	368	290
FB	291	228
CF	3795	3032
FC	4258	3354
DE	-3795	-3032
ED	-1543	-1288
EF	-2956	-2293
FE	-4549	-3582

* FIRST LETTER INDICATES JOINT AT WHICH MOMENT ACTS.

** PLUS MOMENT IS CLOCKWISE ACTING ON TRUSS MEMBER.

FORM 1319A

AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT: C 105	AIR VENTS	REPORT NO. 7/0558/67	
		SHEET NO. 3.0	
		PREPARED BY	DATE
		KAUTT	5/25/56
		CHECKED BY	DATE

SECTION 3

STRESSING

VENTS 3 & 4

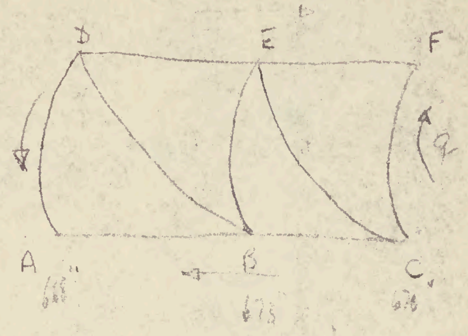
DWG 7-1058-6217
-5105/6

FORM 1319A

AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT:		REPORT NO. 7/0558/67	
C, 105	#3 & #4 VENTS CUT-OUTS FOR ONE WAY AIR COOLING VALVES	SHEET NO. 3.1	
		PREPARED BY	DATE
		[signature]	JAN, 56
		CHECKED BY	DATE

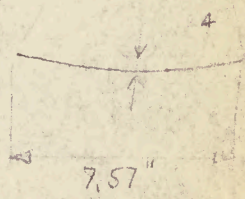
THE LAY-OUT OF THE STRUCTURE IS AS SHOWN ON MK. E. KAUTT'S REPORT. THE STRUCTURE DIFFERS, HOWEVER, IN THE FACT THAT THE SKIN HAS A CURVATURE. THE FRAMEWORK IS THEREFORE LYING ON A CURVED SURFACE.



THE SHEAR FLOW $q = \pm 1600$ LB/INCH

CONSIDER MEMBER FC:

THE BOW IS .24" OVER A CHORD OF 7.57"



RADIUS OF CURVATURE

$$R^2 - (R - .24)^2 = (3.785)^2$$

$$R^2 - R^2 + .48R - .0576 = 14.3262$$

$$R = \frac{14.3838}{.48} = 29.966''$$

A LOCAL RADIUS OF CURVATURE OF 30" WILL BE TAKEN. ANGLE SUBTENDED BY CUT OUT (FROM POINTS OF INTERSECTION OF CENTROIDS)

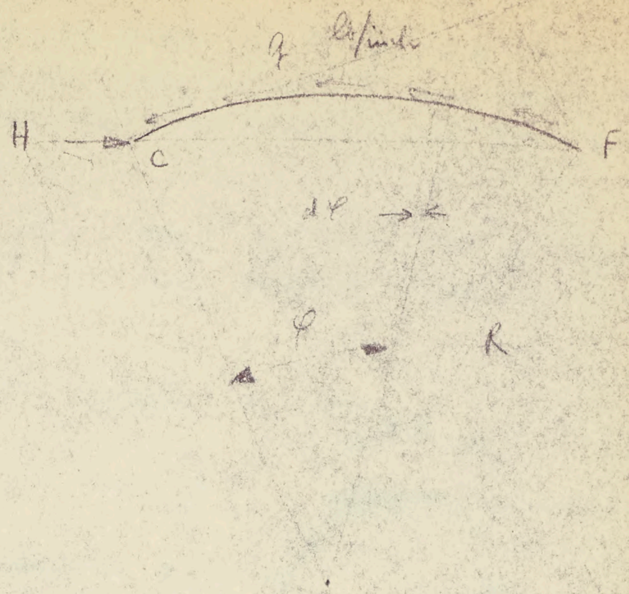
$$\sin\frac{\theta}{2} = \frac{8.25}{2 \times 30} = .1375$$

$$\theta = 15.8^\circ$$

FORM 1319A

AVRO AIRCRAFT LIMITED
MALTON · ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT: C.105	CUT-OUTS FOR ONE-WAY AIR COOLING VALVES #3 & #4 VENTS	REPORT No. 7/0558/67	SHEET No. 3.2
		PREPARED BY [illegible]	DATE JAN, 57
		CHECKED BY	DATE



FORCE ON SEGMENT

$$dF = q\,R\,d\varphi$$

HORIZONTAL COMPONENT $dH = q\,R\cos\varphi\,d\varphi$

$$H = q\,R\sin\varphi\Big]_0^{15.8}$$

$$H = 1600 \times 30.0 \times .27228 = 13070 \text{ LBS} \quad (\text{ULT.})$$

THE MOMENT ABOUT POINT 'C' IS

$$dM = q\,R^2\,(1 - \cos\varphi)\,d\varphi$$

$$M = q\,R^2\,(\theta - \sin\theta)\Big]_0^{15.8^\circ}$$

$$M = 1600 \times 900\,[.27576 - .27228]$$

$$M = 5010 \text{ LB-IN} \quad (\text{ULT.})$$

FORM 1319A

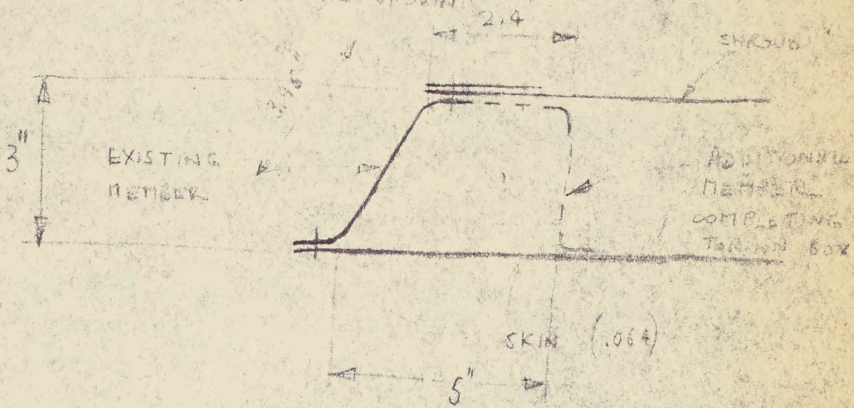
AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT: C.105	CUT-OUTS FOR ONE WAY AIR COOLING VALVES #3 & #4 VENTS	REPORT No. 7/0558/67
		SHEET No. 3.3
		PREPARED BY:	DATE: JAN 56
		CHECKED BY:	DATE:

IT IS UNDESIRABLE TO REACT ALL OF THIS B.M ON THE FRAMES. SINCE FRAMES 668 & 678 ARE SUBJECTED TO EQUAL AND OPPOSITE MOMENTS, IT APPEARS BEST TO INTERCONNECT THESE BY MEANS OF A TORSION TUBE.

THE AMOUNT OF LOAD TAKEN BY THE TORSION MEMBER AND THE FRAMES DEPENDS ON THE RELATIVE STIFFNESSES INVOLVED.

CONSIDER A TORSION MEMBER AS SHOWN:



BOX AREA $A = 11.1 \square''$ *

* THIS DESIGN IS OBSOLETE. REFER PAGE 3.6.

AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT:		REPORT No. 7/0558/67
C.105	CUT-OUTS FOR ONE WAY AIR COOLING VALVES #3 & #4 VENTS	SHEET No. 3.4
		PREPARED BY [signature] — DATE JAN 56
		CHECKED BY — DATE

THE RELATIVE STIFFNESSES OF TORSION BOX & FRAME AT THE POINT OF APPLICATION OF THE MOMENT ARE AS FOLLOWS:

A) TORSION BOX

$$\frac{T}{\theta} = \frac{4A^2G}{L\oint\frac{ds}{t}}$$

$A = 11.1\,\square''$ $G = 4\times10^6$ $L = 4.8''$

$$\oint\frac{ds}{t} = \frac{5}{.064} + \frac{3.95+3}{.040} + \frac{2.4}{.065} = 78 + 174 + 37 = 289$$

$$\frac{T}{\theta} = \frac{4\times123.5\times4\times10^6}{4.8\times289} = 1.43\times10^6 \text{ LB-IN/RADIAN}^*$$

[* SEE PAGE 3.6]

B) IN VIEW OF ITS IRREGULAR SHAPE & OF THE PRESENCE OF THE CUT-OUTS, THE LOCAL ROTATION OF THE FRAME IS DIFFICULT TO ESTIMATE.

THE LOCAL MOMENT OF INERTIA IS $= .50''^4$ (AVERAGE)

LOCAL RADIUS OF CURVATURE $= 30''$

REFERRING TO NACA 929:

IF THE FRAME IS CONSIDERED AS SUPPORTED BY THE SKIN, IT WILL BE ASSUMED THAT, LOCALLY, THE EFFECTIVE SKIN THICKNESS IS HALVED OWING TO THE CUT-OUTS.

FORM 1319A

AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT: C.105	CUT-OUTS FOR ONE WAY AIR COOLING VALVES #3 & #4 VENTS	REPORT NO. 7/0558/67	SHEET NO 35
		PREPARED BY [illegible]	DATE JAN 56
		CHECKED BY	DATE

$$d = \frac{KR^2}{EI} = \frac{.40 \times 10^{6} \times 27 \times 10^{3}}{10^{7} \times .50} = 2160 \quad \text{(NACA. 929)}$$

$$K = \frac{R\,t\,G}{L} = \frac{30 \times .032 \times 4 \times 10^{6}}{9.6} = .40 \times 10^{6}$$

$$\Delta C_{m\phi_m} = 200$$

$$\frac{M}{\Delta\phi} = \frac{.40 \times 10^{6} \times 900}{200} = 1.80 \times 10^{6} \text{ LB-IN/RADIAN}$$

FROM THE ORDER OF RELATIVE STIFFNESSES IT IS FAIR TO ASSUME THAT THE APPLIED MOMENT IS REACTED BY FRAMES & TORSION BOX IN EQUAL PROPORTIONS.

REFERRING AGAIN TO NACA 929:

WITHIN A DISTANCE OF $\pm 20°$ OF THE POINT OF APPLICATION OF THE MOMENT, THE BENDING MOMENT COEFFICIENT WILL DROP FROM ITS INITIAL VALUE OF .5 TO A VALUE OF .1

THUS, THE B.M. IN THE FRAME IS

$$.5 \times \left(\frac{5010}{2}\right) = 1253 \text{ LB-IN (ULT.) AT CUT-OUT}$$

ABOUT 6.5" ON EITHER SIDE, THE B.M. DROPS OFF (LINEARLY) TO 251 LB-IN AND BECOMES NEGLIGIBLE THEREAFTER.

REFERRING TO REPORT 7-0558-22/2 THESE B.M. CAN BE TAKEN BY THE FRAMES WITHOUT NEED OF REINFORCING.

FORM 1319A

A. V. ROE CANADA LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT (Aircraft)

AIRCRAFT:		REPORT NO. 7-0158-67	
C.105	CUT-OUTS #3 & #4 VENTS	SHEET NO. 3.6	
		PREPARED BY	DATE FEB
		CHECKED BY	DATE

REFERRING TO DRAWING 7-0158-210 SHEET 3:

THE TORSION BOX AS SHOWN ON PAGE 3.3 HAS BEEN MODIFIED. IT NOW CONSISTS OF TWO BOXES, ONE ON THE TOP & ONE ON THE BOTTOM EDGE OF THE CUT-OUT.

AREA OF EACH BOX = 3.0 × 2.5 = 7.5 □"

TOTAL $A = 15.0$ □"

$G = 4 \times 10^6$

$L = 4.8$

$$\oint \frac{ds}{t} = \left[\frac{2.5}{.064} + \frac{6}{.040} + \frac{2.5}{1.5 \times .048}\right] \times 2 = 2\left[39.0 + 150 + \frac{52}{1.5}\right]$$

$$= 448$$

$$\therefore \frac{T}{\theta} = \frac{4 \times 225 \times 4 \times 10^6}{4.8 \times 448} = 1.68 \times 10^6 \text{ LB-IN/RADIAN}$$

REFERRING TO PREVIOUS CALCS., THIS STIFFNESS IS SATISFACTORY.

ON THE ASSUMPTION THAT HALF THE APPLIED B.M. IS REACTED HALF BY THE FRAME AND HALF BY THE TORSION BOXES,

$$\text{SHEAR/INCH} = \left(\frac{5010}{2}\right) \times \frac{1}{2} \times \frac{1}{4 \times 7.5} = \frac{5010}{60} = 83.6 \text{ LB/IN}$$

WHICH RESULTS IN A VERY LOW STRESS IN .040" SHEET. THE MATERIAL, HOWEVER, IS REQUIRED FOR STIFFNESS. (N.B. LATEST CHANGES INDICATE THAT USE IS MADE OF THE RAKED DIAPHRAGM TO REACT SHROUD & STIFFENER LOADS – SEE MR. K. IDDON).

FORM 1319A

AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT:		REPORT NO. 7/0558/67	
C.105	CUT-OUTS FOR ONE WAY AIR COOLING VALVES #3 & 4 VENTS	SHEET NO. 3.7	
		PREPARED BY	DATE
		[illegible]	JAN 56
		CHECKED BY	DATE

CONSIDER DIAGONAL MEMBER EC:

THE END LOAD REMAINS MAINLY IN THE STEEL REINFORCING STRAP AND SKIN. OWING TO THEIR CURVATURE, A MOMENT HAS TO BE REACTED.

OFFSET = .24"

LOAD = 15100 LB.

$\therefore$ MOMENT = 15100 × .24 = 3620 LB-IN

THIS MOMENT PRODUCES A STRESS IN THE STEEL & SKIN OPPOSITE TO THAT PRODUCED BY THE END LOADS. HENCE THE SIZES CALCULATED BY MR. KAUTT MUST BE ADEQUATE.

$$\bar{y} = \frac{.85 \times .208}{.500} = .354"$$

$I = .027 + .292 \times (.354)^2 + .208 \times (.446)^2$

$= .027 + .0366 + .0416$

$= .105''^4$

$$f = \frac{3620 \times 1.10}{.105} = 37900 \text{ LB}/\square" \quad \underline{\text{O.K.}}$$

FORM 1319A

TRUSS DEFLECTION (CONT)

THE DEFLECTION OF THE TRUSS JOINTS WILL BE DETERMINED GRAPHICALLY BY MEANS OF A WILLIOT DIAGRAM. THIS IS MORE USEFUL THAN THE ANALYTICAL SOLUTION ON THE PREVIOUS PAGES BECAUSE IT SHOWS THE DISPLACEMENT OF ANY JOINT WITH RESPECT TO ANY OTHER JOINT. THIS WILL BE USEFUL IN DETERMINING MOMENTS AT THE JOINTS & SECONDARY STRESSES IN THE TRUSS MEMBERS.

ASSUMPTIONS:

1) TRUSS MEMBERS AD, BE, & CF REMAIN PARALLEL

2) POINT (D) IS FIXED IN SPACE

3) JOINT RIGIDITY DOES NOT AFFECT DEFLECTION OF TRUSS

AREA OF TRUSS MEMBERS

THE TRUSS MEMBERS, WHICH ARE BASICLY STEEL, ARE CONSIDERED TO HAVE THE .064 75S-T6 SKIN PLUS AN ADDITIONAL PORTION OF FRAME OR STIFFENER WORKING WITH THEM. TO SIMPLIFY THE ANALYSIS, ANY ALUMINUM IS CHANGED TO AN EQUIVALENT AREA OF STEEL. THE SECTION PROPERTIES OF THESE EQUIVALENT SECTIONS ARE CALCULATED ON THE FOLLOWING PAGES. IN CALCULATING THE MOMENT OF INERTIA, ONLY THE STEEL & THE .064 SKIN ARE CONSIDERED. THE ALUMINUM IS CHANGED TO AN EQUIVALENT AREA OF STEEL BY THE RATIO OF E_{AL} TO E_{ST}. THEREFORE,

$$\text{EQUIVALENT AREA OF STEEL, } A_{EQ} = A_{AL}\frac{E_{AL}}{E_{ST}}$$

$$\text{OR,} \quad A_{EQ} = A_{AL}\frac{10.5\times10^6}{29\times10^6} = .362A_{AL}$$

MEMBERS AB, BC, DE, & EF

THESE MEMBERS ARE CONSIDERED TO CONSIST OF THE .051 STEEL STRAP & THE .064 AL SKIN ONLY. WIDTH = 1.55"

$$A_{ST} = (1.55)(.051) + (.362)(1.55)(.064) = .1150\ ''^2$$

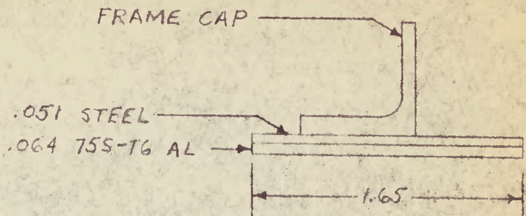
$$\text{EQUIVALENT THICKNESS} = .051 + (.064)(.362) = .0742''$$

$$I_{EQ} = \frac{(.0742)(1.55)^3}{12} = .02303\ ''^4$$

FORM 1319 A

TRUSS DEFLECTIONS (CONT)

MEMBERS AD & CF



THE FRAME CAP IS MADE FROM 75S-T6 EXT; LEGS ARE .08 x .7, & .12 x .7. $A = .13375''^2$

$A_{SKIN} = 1.65 \times .064 = .1056''^2$

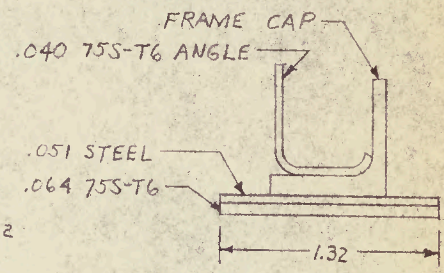
TOTAL AREA OF ALUM: $A_{AL} = .13375 + .1056 = .23935''^2$

$A_{ST} = (1.65)(.051) + (.23935)(.362) = \underline{.1708''^2}$

$t_{EQ} = .0742''$

$$I_{EQ} = \frac{(.0742)(1.65)^3}{12} = \underline{.02778''^4}$$

MEMBER BE



THE FRAME CAP IS THE SAME AS FOR MEMBERS AD & CF. $A = .13375''^2$

AREA OF .040 ANGLE $= .04944''^2$

AREA OF SKIN $= (1.32)(.064) = .08448''^2$

TOTAL AREA OF ALUM $= .13375 + .04944 + .08448 = .26767''^2$

$A_{ST} = (1.32)(.051) + (.362)(.26767) = \underline{.1642''^2}$

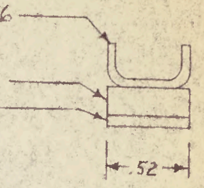
$t_{EQ} = .0742''$

$$I_{EQ} = \frac{(.0742)(1.32)^2}{12} = \underline{.01422''^4}$$

TRUSS DEFLECTIONS (CONT.)

MEMBERS AE & BF

THE AMOUNT OF .051 75S-T6 WORKING WITH AE & BF IS BASED ON EQUAL STRAINS. THE TOTAL LOAD IN THESE MEMBERS IS 15272 # (REF. SHT. 1.1)



IT HAS ALREADY BEEN ASSUMED (REF. SHT. 1.4) THAT 1980 # OF THIS LOAD IS CARRIED IN THE BOX BEAMS WHICH SUPPORTS AE & BF. AN EQUIVALENT AREA OF STEEL FOR THE .051 ALUM. CHANNEL WAS CHOSEN SUCH THAT 1980 # ACTING ON IT WOULD PRODUCE THE SAME STRESS AS 15272 - 1980 = 13292 # WOULD PRODUCE IN THE STEEL. THIS AREA OF ALUM. IS .04351 $''^2$

$$A_{SK} = (.52)(.064) = .03328\ ''^2$$

TOTAL AREA OF ALUM = .03328 + .04351 = .07679 $''^2$

$$A_{ST} = (.52)(.18) + (.362)(.07679) = .1214\ ''^2$$

$$t_{EQ} = .180 + (.064)(.362) = .2032\ ''$$

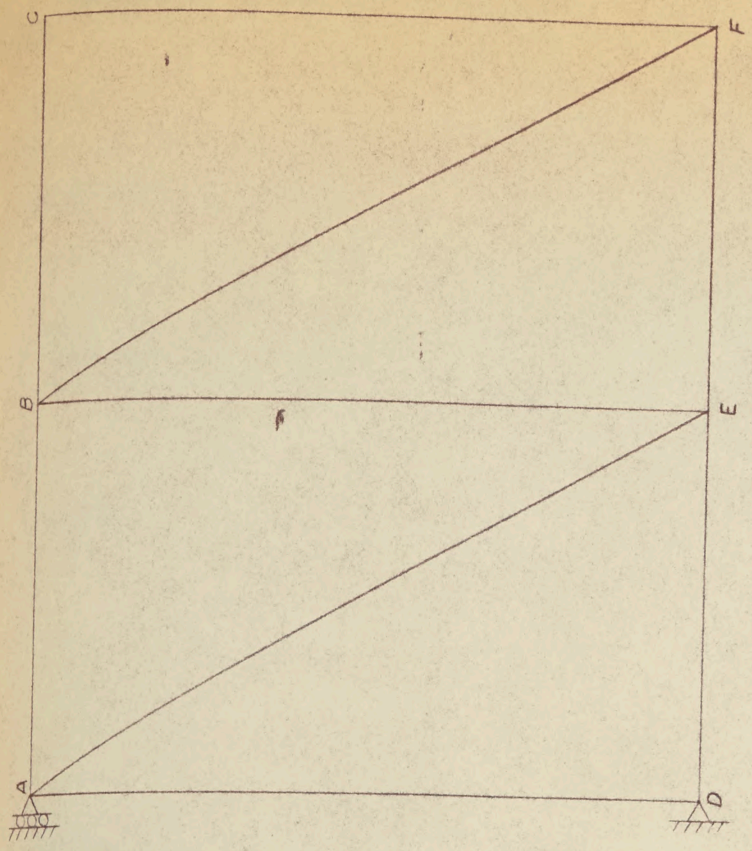
$$I_{EQ} = \frac{(.2032)(.52)^3}{12} = .00238\ ''^4$$

DEFORMATIONS OF TRUSS MEMBERS (Δ)* $E = 29 \times 10^6$ PSI

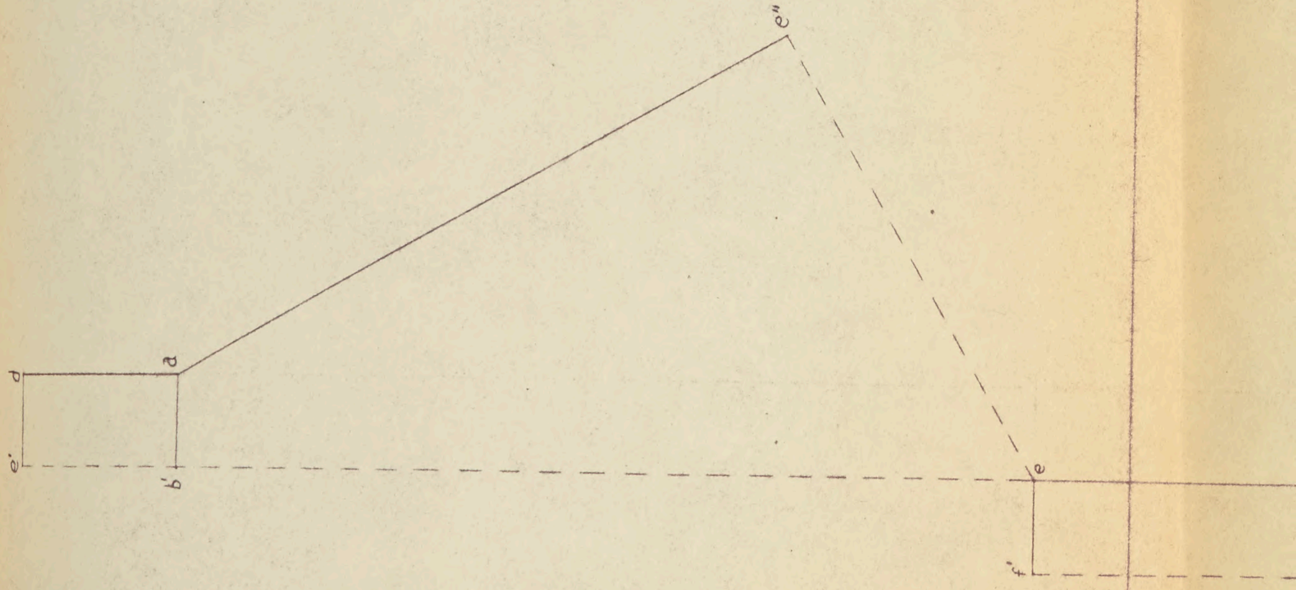
MEMBER	A	L	** P_{AVG}	$P_{AVG}\,L$	AE	$\Delta = P_{AVG}L/AE$
CF	.1708	8.250	-6600	-54450	4,953,200	-.01099
BC	.1150	4.800	-3840	-18432	3,335,000	-.00553
BF	.1214	9.545	15272	145771	3,520,600	.04141
EF	.1150	4.800	-3840	-18432	3,335,000	-.00553
DE	.1150	4.800	-3840	-18432	3,335,000	-.00553
AB	.1150	4.800	-3840	-18432	3,335,000	-.00553
BE	.1642	8.250	-13200	-108900	4,761,800	-.02287
AD	.1708	8.250	-6600	-54450	4,953,200	-.01099
AE	.1214	9.545	15272	145771	3,520,600	.04141

* PLUS Δ IS LENGTHENING OF MEMBER.

** P_{AVG} IS THE AVERAGE LOAD IN THOSE MEMBERS WHICH ARE LOADED BY SHEAR FLOW



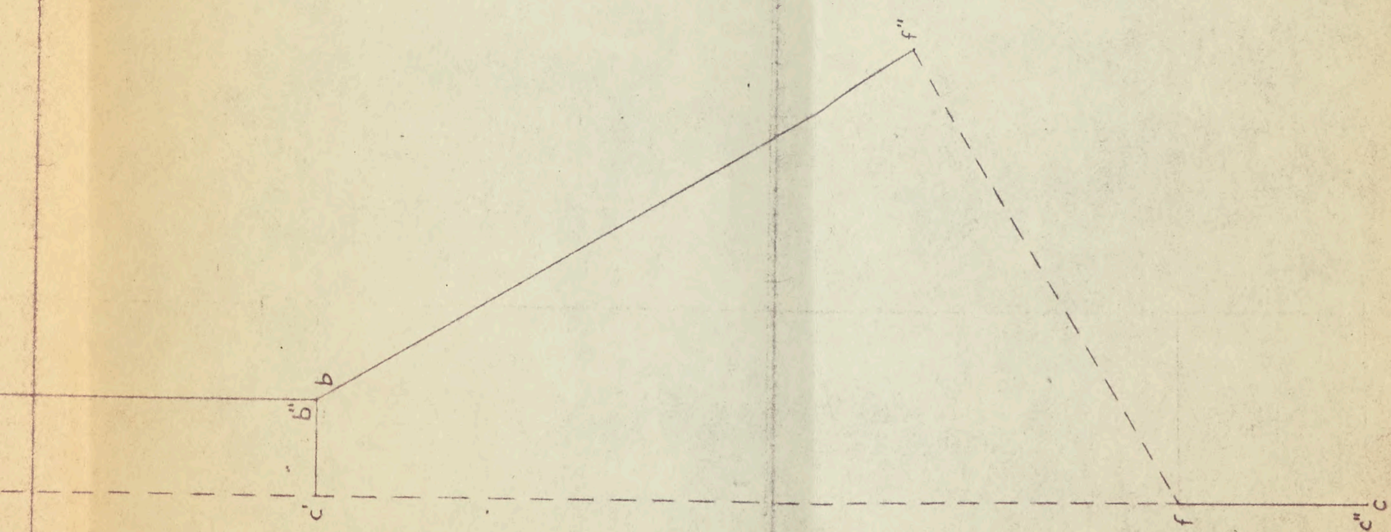
WILLIOT DIAGRA



A. V. ROE CANADA LIMITED MALTON, ONTARIO TECHNICAL DEPT. (AIRFRAME)	
AIRCRAFT: C 105	REPORT NO. 7/0558/67
WEIGHT:	SHEET 2.8
C. G. POSITION:	DATE 2/2/56
	PREPARED BY E. KAUTT

ILLIOT DIAGRAM FOR TRUSS DEFLECTION

SCALE: 1" = .01"



MOMENTS AT JOINTS.

THE MOMENTS IN THE VARIOUS MEMBERS ARE DETERMINED BY THE METHOD OF RELAXATION (HARDY-CROSS). SINCE ALL TRUSS MEMBERS ARE CONSIDERED TO BE FIXED AT BOTH ENDS, & E CONSTANT THROUGHOUT, A RELATIVE STIFFNESS FACTOR OF I/L IS USED. THE FIXED-END MOMENT OF EACH MEMBER IS DETERMINED FROM:

$$F.E.M. = \frac{-6EI\delta}{L^2}$$

WHERE: $E = 29 \times 10^6$ PSI
I = MOMENT OF INERTIA OF MEMBER
L = LENGTH OF MEMBER
δ = DEFLECTION OF ONE END OF MEMBER WITH RESPECT TO OTHER END, MEASURED NORMAL TO MEMBER. DEFLECTIONS ARE SCALED FROM WILLIOT DIAGRAM, SHT 2.8.

	1	2	3	4	5	6	7
			RELATIVE STIFFNESS FACTOR		$6 \times 29 \times (2) \times (4)$	$(1)^2$	$-\frac{(5)}{(6)}$
MEMBER	L	I	I/L	δ *	$6EI\delta$	L^2	F.E.M.
CF	8.250	.02778	.003367	0	0	——	0
BC	4.800	.02303	.004798	.0621	248,848	23.04	-10800
BF	9.545	.00238	.000249	.0306	12,672	91.10	-139
EF	4.800	.02303	.004798	.0740	296,534	23.04	-12870
DE	4.800	.02303	.004798	.0621	248,848	23.04	-10800
AB	4.800	.02303	.004798	.0740	296,534	23.04	-12870
BE	8.250	.01422	.001724	0	0	——	0
AD	8.250	.02778	.003367	0	0	——	0
AE	9.545	.00238	.000249	.0306	12,672	91.10	-139

* SCALED FROM WILLIOT DIAGRAM, SHT. 2.8

DISTRIBUTION FACTORS

THE MOMENT AT ANY JOINT IS DISTRIBUTED TO THE MEMBERS TERMINATING AT THAT JOINT ACCORDING TO EACH MEMBER'S DISTRIBUTION FACTOR (D.F.), WHERE

$$DF = \frac{R.S.F.}{\Sigma R.S.F.}$$

WHERE: R.S.F. IS THE RELATIVE STIFFNESS FACTOR OF THE MEMBER.
ΣR.S.F IS THE SUM OF THE R.S.F.'S OF ALL MEMBERS TERMINATING AT THE JOINT.

A. V. ROE CANADA LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT (Aircraft)

REPORT No. 7/0558/67
SHEET No. 2.10

AIRCRAFT: C 105

ONE-WAY COOLING AIR VALVES
DWG 7-0158-353

PREPARED BY: KAUTT — DATE: 2/6/56
CHECKED BY: — DATE:

MOMENTS AT JOINTS (CONT)

DISTRIBUTION FACTORS (CONT)

JOINT A

MEMBER	R.S.F.	D.F.
AD	.003367	.400
AE	.000249	.030
AB	.004798	.570
Σ	.008414	1.000

JOINT B

MEMBER	R.S.F.	D.F.
BA	.004798	.415
BE	.001724	.149
BF	.000249	.021
BC	.004798	.415
Σ	.011569	1.000

JOINT C

MEMBER	R.S.F.	D.F.
CF	.003367	.412
CB	.004798	.588
Σ	.008165	1.000

JOINT D

MEMBER	R.S.F.	D.F.
DA	.003367	.412
DE	.004798	.588
Σ	.008165	1.000

JOINT E

MEMBER	R.S.F.	D.F.
ED	.004798	.415
EA	.000249	.021
EB	.001724	.149
EF	.004798	.415
Σ	.011569	1.000

JOINT F

MEMBER	R.S.F.	D.F.
FE	.004798	.570
FB	.000249	.030
FC	.003367	.400
Σ	.008414	1.000

SOLUTION BY HARDY-CROSS FOR MOMENTS AT JOINTS

JOINT	A				B				
	1	2	3	4	5	6	7	8	9
MEMBER	AD	AE	AB		BA	BE	BF	BC	
DIST. FACTOR	.400	.030	.570		.415	.149	.021	.415	
	0	-139.0	-12870.0		-12870.0	0	-139.0	-10800.0	
	5203.6	390.3	7415.1		9880.8	3547.4	500.0	9880.8	
	2224.8	250.0	4940.4		3707.6	1773.7	195.2	3175.2	
	-2966.2	-222.4	-4226.6		-3673.4	-1318.9	-185.9	-3673.4	
	-1553.7	-93.0	-1836.7		-2113.3	-659.4	-111.2	-2217.4	
	1393.4	104.4	1985.6		2117.0	760.0	107.2	2117.0	
	683.9	53.6	1058.5		992.8	380.0	52.2	976.0	
	-718.4	-53.8	-1023.8		-996.4	-357.8	-50.4	-996.4	
	-361.6	-25.2	-498.2		-511.9	-178.9	-26.9	-516.0	
	354.0	26.6	504.4		512.0	183.8	25.9	512.0	
	176.6	13.0	256.0		252.2	91.9	13.3	252.1	
	-178.2	-13.4	-254.0		-253.0	-90.8	-12.8	-253.0	
Σ	4258.2	291.1	-4549.3		-2955.6	4131.0	367.6	-1543.1	

JOINT	D				E			
MEMBER	DA		DE		ED	EA	EB	EF
DIST. FACTOR	.412		.588		.415	.021	.149	.415
	0		-10800.0		-10800.0	-139.0	0	-12870.0
	4449.6		6350.4		9880.8	500.0	3547.4	9880.8
	2601.8		4940.4		3175.2	195.2	1773.7	3707.6
	-3107.4		-4434.8		-3673.4	-185.9	-1318.9	-3673.4
	-1483.1		-1836.7		-2217.4	-111.2	-659.4	-2113.3
	1367.8		1952.0		2117.0	107.2	760.0	2117.0
	696.7		1058.5		976.0	52.2	380.0	992.8
	-723.2		-1032.0		-996.4	-50.4	-357.8	-996.4
	-359.2		-498.2		-516.0	-26.9	-178.9	-511.9
	353.2		504.2		512.0	25.9	183.8	512.0
	177.0		256.0		252.1	13.3	91.9	252.2
	-178.4		-254.6		-253.0	-12.8	-90.8	-253.0
Σ	3794.8		-3794.8		-1543.1	367.6	4131.0	-2955.6

JOINTS

A. V. ROE CANADA LIMITED
MALTON, ONTARIO
TECHNICAL DEPT. (AIRFRAME)

AIRCRAFT - - C 105
WEIGHT - -
C. G. POSITION -

REPORT NO. - 7/0558/67
SHEET - - 2.11
DATE - - 2/6/56
PREPARED BY - KAUTT

7	8	9	10	11	12	13	14	15	16	17	18	19
				C								
BF	BC		CB		CF							
.021	.415		.588		.412							
-139.0	-10800.0		-10800.0		0							
500.0	9880.8		6350.4		4449.6							
195.2	3175.2		4940.4		2601.8							
-185.9	-3673.4		-4434.8		-3107.4							
-111.2	-2217.4		-1836.7		-1483.1							
107.2	2117.0		1952.0		1367.8							
52.2	976.0		1058.5		696.7							
-50.4	-996.4		-1032.0		-723.2							
-26.9	-516.0		-498.2		-359.2							
25.9	512.0		504.2		353.2							
13.3	252.1		256.0		177.0							
-12.8	-253.0		-254.6		-178.4							
367.6	-1543.1		-3794.8		3794.8							
				F								
EB	EF		FE	FB	FC							
149	.415		.570	.030	.400							
0	-12870.0		-12870.0	-139.0	0							
3547.4	9880.8		7415.1	390.3	5203.6							
1773.7	3707.6		4940.4	250.0	2224.8							
-1318.9	-3673.4		-4226.6	-222.4	-2966.2							
-659.4	-2113.3		-1836.7	-93.0	-1553.7							
760.0	2117.0		1985.6	104.4	1393.4							
380.0	992.8		1058.5	53.6	683.9							
-357.8	-996.4		-1023.8	-53.8	-718.4							
-178.9	-511.9		-498.2	-25.2	-361.6							
183.8	512.0		504.4	26.6	354.0							
91.9	252.2		256.0	13.0	176.6							
-90.8	-253.0		-254.0	-13.4	-178.2							
4131.0	-2955.6		-4549.3	291.1	4258.2							

A. V. ROE CANADA LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7/0558/67
SHEET NO. 2.12

AIRCRAFT:		PREPARED BY	DATE
C 105	ONE-WAY COOLING AIR VENTS DWG 7-0158-353	KAUTT	2/7/56
		CHECKED BY	DATE

SUMMARY OF MOMENTS IN MEMBERS

*TRUSS MEMBER	**MOMENT
AD	4258
DA	3795
AB	-4549
BA	-2956
AE	291
EA	368
BC	-1543
CB	-3795
BE	4131
EB	4131
BF	368
FB	291
CF	3795
FC	4258
DE	-3795
ED	-1543
EF	-2956
FE	-4549

* FIRST LETTER INDICATES JOINT AT WHICH MOMENT ACTS.

** PLUS MOMENT IS CLOCKWISE MOMENT ACTING ON TRUSS MEMBER.

FORM 1318A

A. V. ROE CANADA LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT (Aircraft)

REPORT No. 7/0558/67
SHEET No. 2.13

AIRCRAFT:		PREPARED BY	DATE
C 105	ONE-WAY COOLING AIR VALVES DWG 7-0158-353	KAUTT	2/7/56
		CHECKED BY	DATE

CHANGE IN TRUSS AXIAL LOADS

THE MOMENTS IN THE TRUSS MEMBERS (SHOWN ON SHT. 2.12) INDICATE THAT A PORTION OF THE LOAD IS CARRIED AS SHEAR IN THE MEMBERS INSTEAD OF ALL THE LOAD BEING TAKEN AS AXIAL LOAD. THE AXIAL LOADS SHOWN ON SHT. 2.7 WILL NOW BE CORRECTED, TAKING THE EFFECT OF THE MOMENTS INTO ACCOUNT. THIS WILL BE DONE BY FINDING THE LOADS AT THE JOINTS DUE TO THE MOMENTS ACTING ON THE MEMBERS, FINDING AXIAL LOADS IN THE MEMBERS DUE TO THESE LOADS, & SUPERIMPOSING THESE NEW AXIAL LOADS ON THE ORIGINAL LOADS.

THE LOAD AT A JOINT IS FOUND BY ADDING THE MOMENTS AT EACH END OF A MEMBER & DIVIDING BY THE LENGTH OF THE MEMBER, SUCH THAT THE MOMENT ACTING ON THE MEMBER IS CONVERTED TO A COUPLE WITH AN ARM EQUAL TO THE LENGTH OF THE MEMBER. THE MOMENTS ACTING ON THE MEMBERS ARE SHOWN IN THE SKETCH BELOW.